The sensitivity of life insurance firms to interest rate changes

Kyal Berends, Robert McMenamin, Thanases Plestis, and Richard J. Rosen

Introduction and summary

The United States is in a period of low interest rates following the Great Recession, which lasted from late 2007 through mid-2009. And the Federal Reserve recently reaffirmed expectations for a lengthy period of low rates, likely to last at least through mid-2015.[1] Low interest rates are expected to reduce the cost of investing in the United States. In turn, increased levels of investment are expected to decrease unemployment over time—an objective that is consistent with the maximum employment component of the Federal Reserve's dual mandate.[2]

While a prolonged period of low interest rates is intended to achieve a broad macroeconomic policy objective, individual sectors of the economy may be more or less sensitive to changes in interest rates. Thus, the impact of the policy on these sectors will vary accordingly. In this article, we focus on the impact of the interest rate environment on the life insurance industry, which is an important part of the U.S. economy and its financial system. Life insurance companies held $5.6 trillion in financial assets at year-end 2012, compared with $15.0 trillion in assets held by banks at year-end 2012.[3] In addition to life insurers being large in absolute terms, these companies have special significance in that they hold large amounts of specific types of assets. For instance, life insurers held 6.2 percent of total outstanding credit market instruments, including 17.8 percent of all outstanding corporate and foreign bonds, in the United States (see figure 1).[4]

Life insurers are exposed to the interest rate environment because they sell long-term products whose present value depends on interest rates. On a fundamental level, the products satisfy two objectives for customers. The first objective is that insurance customers want protection from adverse financial consequences resulting from either loss of life (by buying life insurance policies) or exhaustion of financial resources over time (by buying annuity policies). The second objective is to allow customers to save (generally in a tax-advantaged way) for the future. Because customers are expected to receive cash from their policies years after they have been issued, life insurers face the challenge of investing the customers' payments in such a way that the funds are available to satisfy policyholders in the distant future. This feature generally leads life insurers to invest in a collection of long-term assets, mostly bonds. Life insurers generally invest largely in fixed-income securities because most of their liabilities are

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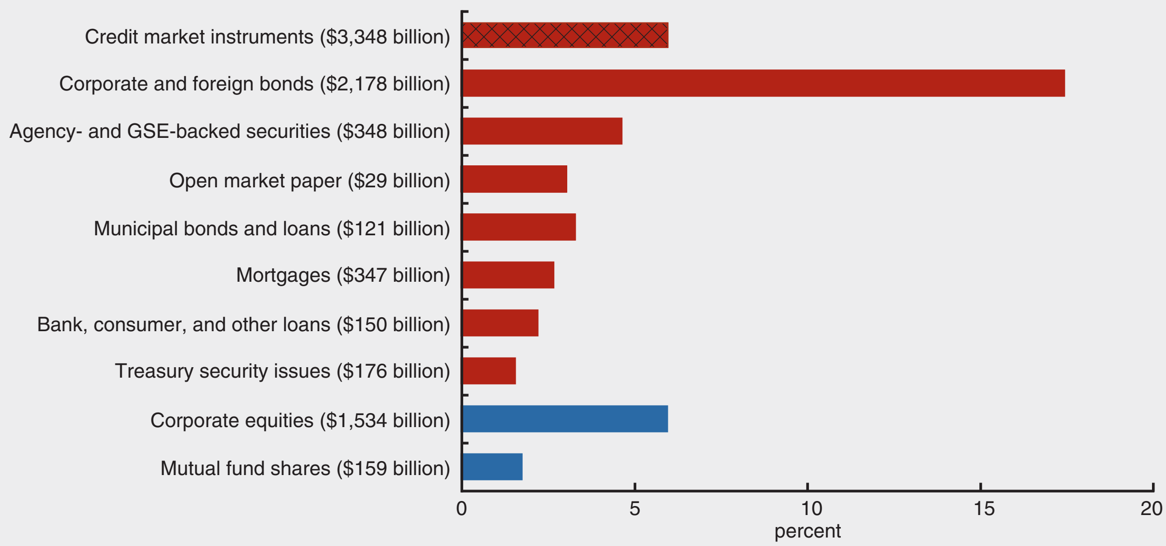
FIGURE 1

Life insurance industry's aggregate share of assets, 2012



Notes: The percent plotted is the year-end value of the life insurers' holdings in the specified financial instrument(s) over the total outstanding value of the financial instrument(s) in the market. Credit market instruments (in red) are an aggregate of the following types of instruments: corporate and foreign bonds; government-agency- and government-sponsored-enterprise-backed securities (agency- and GSE-backed securities); open market paper; municipal bonds and loans; mortgages; bank, consumer, and other loans; and Treasury security issues. The dollar values of credit market instruments do not total because of rounding.

Source: Authors' calculations based on data from the Board of Governors of the Federal Reserve System (2013).

largely (though not exclusively) fixed in size. For example, at the end of 2012, 38.9 percent of life insurance companies' assets were corporate and foreign bonds.[5] As interest rates change, the values of a life insurer's assets and liabilities change, potentially exposing the company to risk. Life insurers choose assets to back their liabilities with interest rate risk in mind but may not choose to—or may not be able to—completely balance the interest rate sensitivity of their assets and liabilities. This conflict arises in part because assets with maturities as long as those of some insurance liabilities are not always available. Moreover, there is an additional complication. Many life insurance and annuity products have embedded guarantees or attached riders that promise policyholders a minimum return over the duration of their policies. As interest rates decrease, these guarantees or riders can affect how sensitive these products are to interest rate changes.

Life insurers are also exposed to interest rate risk through the behavior of policyholders. The interest rate environment affects demand by policyholders for certain insurance products. For example, fixed-rate annuities can promise a prespecified return for investments over a potentially extended period. When interest rates are very low, as they are currently, life insurers can only make money on these annuities if they offer policyholders a low return. There is less demand for annuities under these conditions. Also, many insurance products offer policyholders the option to contribute additional funds at their discretion or to close out a contract in return for a predetermined payment (in the latter case, the policyholder is said to surrender the contract; see the next section for details). When interest rates change, it is more likely that policyholders will act on these options. For example, they may contribute more to an annuity with a high guaranteed return when interest rates are low or surrender an annuity with a low return guarantee if interest rates rise significantly.

There is a widespread belief—both among investors and life insurance firms—that the current period of low interest rates is bad for life insurance firms. The stock prices of life insurers fell in a strong stock market. From the end of December 2010 through the end of December 2012, the Standard & Poor's (S&P) 500 Life & Health Index, which tracks the stock performance of life and health insurance firms in the United States, decreased 9.1 percent, whereas the S&P 500 Index, which tracks the stock performance of the top 500 publicly traded firms of the U.S. economy, increased 18.5 percent; all the while, interest rates fell significantly.[6] Life insurance executives also appear to be concerned about the low-rate environment. In a 2012 Towers Watson survey, 45 percent of life insurers' chief financial officers expressed the view that prolonged low interest rates pose the greatest threat to their business model.[7]

In this article, we examine the sensitivity of the life insurance sector to interest rate risk both before and during the current low-rate period. We do this by analyzing the sensitivity of publicly traded life insurance firms' stock prices to changes in bond returns.[8] Our sample runs from August 2002 through December 2012, so in addition to the recent low-rate period, it includes a relatively calm period and the financial crisis. The relationship between life insurer stock returns and bond returns changes over our sample period and, interestingly, differs across life insurance firms of various sizes. Prior to the financial crisis, stock prices of life insurance firms were not significantly correlated with ten-year Treasury bond interest rates. After the crisis, stock returns of life insurance firms show a negative correlation with bond returns. In other words, the stock prices decreased when bond prices increased (that is, when interest rates decreased).[9] This negative correlation between life insurance firms' stock prices and bond returns was driven by changes in the stock prices of large insurance firms. We find that the larger the firm (in terms of total assets held), the higher the negative correlation between its stock price and bond returns. For the small life insurance firms we study—which are not that small because they have publicly traded stock—there was essentially no correlation between their stock prices and bond returns.

Our results, at least for large life insurance firms in the recent low-rate period, imply that life insurers are hurt when bond prices rise—that is, when interest rates fall. This pattern is consistent with liabilities being longer-lived than assets. It is also consistent with future profit opportunities for life insurance firms getting worse as interest rates decrease.

We also show that the recent period of persistent low interest rates is different than earlier times. There is reason to believe that many of the guarantees that life insurance firms wrote before interest rates fell are now *in the money*—that is, when the guaranteed rate is above what policyholders could get from putting their cash value in new similar investments. Because of this, policyholders are less likely to access the cash value in their policies, effectively lengthening the liabilities' maturities. In addition, it is difficult for life insurers to sell certain products, such as some annuities, when interest rates are low. These factors suggest that in the current low-rate period, returns to life insurance firms should be low and their sensitivity to interest rate changes should be greater than in periods with higher interest rates. We find evidence for both of these effects among large life insurance firms.

In the next two sections, we present extended descriptions of life insurance companies' liabilities, assets, and derivatives as background for our analysis. Then, we analyze how exposed life insurers are to interest rate fluctuations and discuss our results and their implications.

Life insurance company liabilities

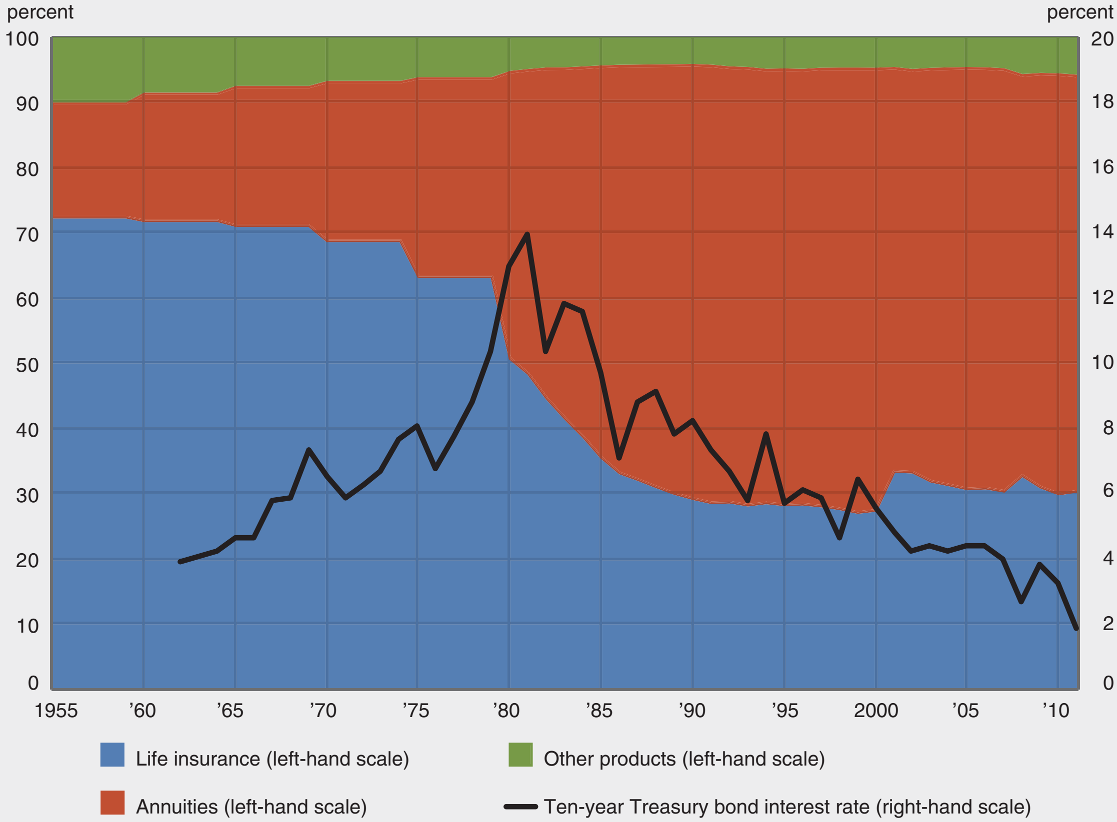
Life insurance can be considered a liability-driven business. Life insurers take in funds today in exchange for the promise to make conditional payments in the future. The products they sell, which make up the vast majority of their liabilities, meet several policyholder objectives, but we focus on the two most prominent ones. The first objective—protection—compensates the policyholder following an adverse event, such as loss of life. The second objective—savings—allows the policyholder to accumulate wealth over time. There are many products offered by the life insurance industry that provide both protection and savings. For that reason, in this section, we discuss the life insurance industry's liabilities by product category and comment on the extent to which each product type provides protection and savings.

Life insurers sell products that can be broadly categorized into three types: life insurance, annuities, and deposit-type contracts. Life insurers' reserves, which are the amounts (of assets) set aside to fulfill future policyholder payments, can be used to illustrate the relative importance of these product types.[10] As figure 2 shows, historically, life insurance was the most important product. However, in recent decades, annuities have become more important. At the end of 2011, 64 percent of the life insurance industry's total reserves were for annuities, while 30 percent of them were for life insurance.[11] The remaining 6 percent of reserves were largely for accident and health contracts. This composition is in stark contrast to that of 1960, for example, during which 72 percent of total reserves were for life insurance and just 18 percent were for annuities.

Most of the growth in the share of reserves for annuities took place in the 1970s and 1980s, periods when interest rates were rising, as reflected in the benchmark ten-year Treasury bond interest rate (see figure 2). Since the 1990s, the share of reserves for annuities has held stable at about 60 percent.[12] Note that other trends, such as the changing of tax treatment for retirement savings and the decline of corporate defined benefit pension plans in favor of defined contribution plans, may have affected the growth of annuities.[13] Importantly, the 1980s were also a period when variable annuities, which allowed insurance customers to take advantage of booming equity prices, grew in popularity.[14]

FIGURE 2

Life insurance policy reserves, by product type, and the ten-year Treasury bond rate



Notes: The data for life insurance policy product types before 1980 are reported every five years and smoothed linearly; data from 1980 onward are reported annually. Prior to 2001, deposit-type contracts are included in the annuities values. Starting in 2001, deposit-type products are excluded from the measure of reserves shown here. Deposit-type contracts are similar to bank certificates of deposit in that policyholders receive interest and principal in exchange for making deposits. The data for other products are largely those for accident and health contracts.
Sources: Authors' calculations based on data from the American Council of Life Insurers (2012) and SNL Financial.

In the remainder of this section, we discuss the product types that life insurers offer in more detail. Table 1 presents a description of the products, along with the life insurance industry's aggregate reserves for them in the fourth quarter of 2012.

Insurance products

With a life insurance policy, beneficiaries receive a lump-sum payment upon the death of the policyholder. Life insurance policies are structured in various forms and, in many cases, may allow the policyholders to extract benefits from their policies even if death has not occurred. Life insurance policies can be broadly classified into three types: term life insurance, whole life insurance, and universal life insurance.

Term life insurance is typically considered the simplest form of life insurance. With this type of policy, the insurer promises to pay out a fixed sum of cash upon death of the policyholder (this is called the death benefit).[15] In exchange, the policyholder contributes fixed monthly premiums. Term life policies have a fixed contract length during which the policyholder is covered (and the policy beneficiaries are guaranteed the death benefit as long as certain conditions are met). Coverage exists over the contract period as long as the policyholder continues to pay premiums (that is, the policy does not lapse). If death occurs within the span of this coverage period, the policy beneficiaries are paid; otherwise, they are not. In this sense, term life insurance is purely a protection product because other than death there is no mechanism by which to extract money from the policy. As of 2012, 16.7 percent of the industry's aggregate life insurance reserves and just 5.2 percent of its total reserves were for term life insurance (see table 1).[16]

TABLE 1

Life insurance industry products and their typical characteristics

Type	Product	Percent of policy reserves for product as of 2012	Payment structure	Maturity	Option to withdraw before maturity	Protection element	Savings element (rate earned)	Separate or general account
Insurance	Universal life	12.5	Flexible premium paid periodically	Age 95 or older	Cash surrender value (increases over time)	Pays regardless of when death occurs	Current interest rate with guaranteed minimum	General
	Whole life	8.9	Fixed premium paid periodically	Age 100	Cash surrender value (increases over time)	Pays regardless of when death occurs	Low fixed rate	General
	Term life	5.2	Fixed premium paid periodically	Set number of years (contract will specify fixed number of years, for example, ten, 15, or 20 years)	None	Pays if death occurs within a set number of years	None	General
	Disability insurance	2.3	Group (institutional) annual premium, adjusted for experience	Renewed annually	None	Pays monthly benefit if disability occurs before normal retirement	None	General
	Other types of insurance	2.3	—	—	—	—	—	—
Annuity	Variable annuity	32.7	Most commonly single premium paid upfront	Flexible	Market value with penalty that decreases over time	Pays full account value on death	Variable return based on performance of selected assets or fund	Separate
	Deferred annuity	23.8	Most commonly single premium paid upfront	Flexible (contract may specify a fixed age, for example, 80)	Account value with penalty that decreases over time	Pays full account value on death	Current interest rate or index return with guaranteed minimum	General
	Immediate annuity	1.5	Single premium paid upfront	Later of term certain or death	None	Pays fixed amount per month during remaining lifetime	None	General
	Other types of annuity	2.0	—	—	—	—	—	—
Deposit-type contract	Funding agreement/ guaranteed investment contracts (GICs)	6.8	Institutional product, single premium paid upfront	Three to seven years	Account value with possible adjustment	None	Guaranteed fixed rate	General
	Other types of deposit-type contract	2.0	—	—	—	—	—	—

Notes: The third column is for the percent of policy reserves as of year-end 2012. The other types of insurance, annuity, and deposit-type contract categories include policies such as nondisability accident policies and health and group pension policies.
Sources: Authors' calculations based on data from Durham and Isenberg (2012), Shiner (2012), SNL Financial, and Sullivan (2012).

Whole life insurance also fulfills a protection objective. It offers a death benefit—a fixed sum of cash paid to the beneficiaries upon the policyholder's death—in exchange for the receipt of premiums. However, unlike term insurance, whole life insurance also includes a savings element. Embedded in every whole life policy is a "cash surrender value"—an amount of cash (which changes over the life of the policy) that can be collected from the policy in the event that the policyholder wishes to terminate coverage and cease premium payments (that is, surrender the policy).[17] Generally, the amount of cash that can be collected grows each policy period in accordance with a fixed schedule. In effect, this growth guarantees some minimum rate of return to the policyholder for each year the policy remains in force. It is intended to satisfy the policyholder's need for savings.

A brief example may clarify how the cash surrender value accrues. Assume that a 35-year-old customer is issued a whole life policy that expires at age 100. The death benefit is $100,000, and the customer pays $1,500 in premiums each year. Part of the premiums are for overhead costs and some of them are set aside for mortality coverage (that is, the policy's protection element). The remainder goes toward the cash surrender value. It is typical that in the first few years of the policy, no cash surrender value accrues. This is because the insurer faces large upfront costs in acquiring the policy (such as agent commissions) and uses the customer's premium payments largely to satisfy those costs. However, after a certain number of years—say, two years in this example—the policyholder begins to accrue cash surrender value. Accrual is typically slow in the early years but accelerates as the policy matures. Assume that the cash surrender value accrues at a rate of $1,000 per year starting in the third year and that it also earns 1.5 percent in annual interest. Then, if the policyholder surrenders the policy at age 50, the cash surrender value will be $14,450 ($1,000 for 13 years plus the 1.5 percent return on the cash surrender value each year). But if the policyholder surrenders the policy at age 65, the cash surrender value will grow to $34,999. Growth is usually structured so that by the end of the policy (at age 100) the cash surrender value will equal the death benefit.

Another difference between term life insurance and whole life insurance is the length of the arrangement. Unlike the often short length of a term life policy, a whole life policy, unless surrendered, covers the policyholder through a fixed age—often to 100 years old.[18] As of 2012, 28.5 percent of the industry's aggregate life insurance reserves and 8.9 percent of its total reserves were for whole life insurance (see table 1).

Universal life insurance is similar to whole life insurance. In both universal life and whole life policies, premiums are paid to the insurer in exchange for a death benefit and an accrual of cash surrender value. The death benefit delivers protection, while the cash surrender value delivers savings. The key feature that differentiates universal life policies from whole life policies is the flexibility of the premium payments. In a whole life policy, premiums are fixed. In a universal life policy, premiums can fluctuate, which means that the buildup of cash surrender value can also fluctuate. Generally, if more premiums are paid, more cash surrender value is accrued. The mechanics of a typical policy are as follows. The customer makes a first premium payment to initiate the policy. After a portion of the first and subsequent premium payments is subtracted for the insurer's overhead costs and mortality coverage costs, the rest is accrued as cash surrender value. This value grows as interest is credited and as future premiums are contributed.[19] The rate at which the cash surrender value earns interest may fluctuate with current market rates, but there is typically a minimum guaranteed interest rate that the policyholder receives regardless of the investing environment.

To better understand the mechanics of flexible premium payments, consider the following example. Assume that a 35-year-old customer is issued a universal life policy that expires at age 100. The death benefit is initially $100,000, and the customer pays $1,500 in premiums for the first five years. Initially, no cash surrender value accrues—similar to what happens in the whole life policy scenario given earlier. Assume that cash surrender value accrual begins after two years. Also assume that the insurer's total charge to the policyholder for overhead and mortality coverage is $500 per year. That means that with $1,500 in premiums per year, the cash surrender value accrues at a rate of $1,000 per year in the third through fifth years, for a total of $3,000. If the cash surrender value of the policy earns 1.5 percent in interest per year, the net value at the end of the fifth year is $3,091. Then, let us say in the sixth year, the customer pays only $1,200 in premiums. Holding fixed the $500 charge for overhead and mortality coverage means that the cash surrender value would increase by only $700 annually ($1,200 – $500). By the end of the sixth year, the cash surrender value would grow to $3,848 (($3,091 + $700) × 1.015). Under a typical universal life insurance contract, if the policyholder chooses not to pay any premiums in the seventh year, the annual charge for overhead and mortality coverage is taken from the cash surrender value. This means that the cash surrender value of the policy would decrease by $500 in the seventh year.

The other key feature that differentiates universal life policies from whole life policies is the flexibility of the death benefit. That is, the policyholder may adjust the death benefit over the course of the policy. In our universal life insurance example, the policy's death benefit stayed constant at $100,000. However, the policyholder could have decided, for example, to increase the policy's death benefit before sending a child to college.[20] Doing so would have led to higher periodic mortality coverage costs, which would have resulted in a slower rate of accrual of the cash surrender value (under the assumption that premium payments did not change). So, returning to the example, note that the policyholder's decision to increase the death benefit could result in the annual $500 charge for overhead and mortality coverage being increased to $550 or higher. Alternatively, the customer could have chosen to decrease the policy's death benefit after the child graduated from college, which would have reduced the policy's mortality coverage costs and potentially quickened the pace of accrual of cash surrender value.[21] This decision could cause the policy's annual charge for overhead and mortality coverage to drop from $500 to $450 or lower. So, both premium payments and the death benefit are flexible in a universal life policy, differentiating it from a whole life policy. As of 2012, 40.0 percent of the industry's aggregate life insurance reserves and 12.5 percent of its total reserves were for universal life insurance (see table 1). It is the most popular insurance product.

Other forms of insurance, such as disability, accident, and health insurance, are also sold by life insurers. These products are purely for protection (for example, against occupational injuries) and typically supplement traditional medical insurance. As of 2012, 4.6 percent of the life insurance industry's total reserves were for these products, which are often sold by specialty insurance companies (see table 1). These forms of insurance are not the focus of the analysis here.

Annuities

Annuities deliver a stream of future payments to the policyholder in exchange for the earlier payment of one or more premiums. In this sense, the structure of annuities somewhat resembles that of life insurance. However, annuities and life insurance are very different. With a life insurance policy, the policyholder has bought protection against the adverse financial consequences of early death. The protection payment is typically made in a lump sum when the policyholder dies. With an annuity, the policyholder has bought protection against the adverse consequences of outliving one's financial resources (that is, of living too long). The protection payments are made periodically until the policyholder dies.[22] Note that a life insurance policy's protection function is precisely the opposite of an annuity's: Life insurance policies protect against early death, while annuities protect against late death. However, life insurance and annuities sometimes share a similar savings component. Like whole life and universal life policies, certain annuities feature a cash surrender value that accrues over time and can be withdrawn upon surrender (that is, termination of the policy). Therefore, the means for generating savings is roughly similar. Broadly speaking, three types of annuities are sold: fixed immediate annuities, fixed deferred annuities, and variable annuities.[23] They differ in the degree of protection and savings provided to policyholders.

Fixed immediate annuities deliver a stream of fixed payments over the lifetime of the policyholder. These payments are made in exchange for a single upfront premium. Because of this feature, these policies are known as single premium immediate annuities (SPIAs). They typically do not include a cash surrender value, and as such, they are purely protection products.[24] As of 2012, just 2.5 percent of the industry's aggregate annuity reserves and 1.5 percent of its total reserves are for fixed immediate annuities (see table 1).

Fixed deferred annuities come in two forms. The first is the single premium deferred annuity (SPDA). This annuity is very similar to an SPIA because a single upfront premium finances all future payments. However, unlike an SPIA, an SPDA defers future payments—usually five to ten years—while the initial premium accrues interest.[25] For example, a policyholder can open an SPDA policy at age 55 and then not withdraw funds from the policy until age 65. The other form of fixed deferred annuities is the flexible premium deferred annuity (FPDA). Similar to universal life insurance, an FPDA allows premium payments to vary by frequency and amount. The value of future payments from the FPDA depends on the timing and amount of contributed premiums.

Both types of fixed deferred annuities can fulfill a savings objective because they feature a cash value. However, the mechanics of fixed deferred annuities are slightly different from those of life insurance policies. A fixed deferred annuity can be in one of two phases. Initially, it is in the buildup phase, during which the policyholder contributes premiums to grow a cash value (net of policy expenses). As in whole life and universal life policies, the insurer augments the cash value by paying interest at a rate known as the crediting rate.[26] After some period of buildup, the annuity enters the withdrawal phase, during which the cash value can be either "annuitized" (withdrawn in periodic payments for life) or withdrawn in one lump sum. Many policyholders opt to never annuitize their policies, preferring instead the full withdrawal option. A full withdrawal from a fixed deferred annuity is akin to withdrawing the entire cash surrender value of a whole life or universal life insurance policy before death. In both cases, the policyholder removes from the policy a value of cash that has accrued over time, satisfying a savings objective. But in doing so, the policyholder sacrifices the protection objective that would have been achieved had the policy been annuitized (in the case of the fixed deferred annuity) or allowed to continue (in the case of the whole life or universal life insurance policy). Therefore, the decision to annuitize versus fully withdraw the cash value determines the extent to which the fixed deferred annuity acts as a protection vehicle or a savings vehicle. Because people are increasingly using annuities to save for retirement, most annuity reserves back policies that are in the buildup phase. At the end of 2011, 93 percent of annuity reserves backed policies in the buildup phase and only 7 percent backed annuitizing policies.[27] As of 2012, 39.7 percent of the industry's aggregate annuity reserves and 23.8 percent of its total reserves were for fixed deferred annuities (see table 1, p. 51).

Variable annuities have several features that distinguish them from fixed immediate and fixed deferred annuities. While they do offer a cash value like fixed deferred annuities (and therefore fulfill a savings objective), the growth of the cash value is not tied to prespecified crediting rate rules. Instead, growth is determined by the performance of a pool of underlying investments. If the pool of investments performs well, more cash value accumulates; and the policyholder who opts to annuitize the policy will have larger periodic payments.[28] If the pool performs poorly, cash value growth slows; and the policyholder who opts to annuitize the policy will have smaller periodic payments. Therefore, all investment returns are essentially passed through to the policyholder. Because of this feature, the policyholder is given discretion regarding the composition of the investment pool.[29] Since policyholders tend to favor equities, a significant portion of variable annuity premiums are commonly invested in equities and equity indexes, such as the S&P 500. This leaves returns from variable annuity policies quite susceptible to changing equity market conditions.

Insurance companies typically offer riders that can be purchased along with variable annuities. Although the riders vary in structure, they share the common function of effectively guaranteeing a minimum rate of growth to the annuity's cash value. For example, a variable annuity by itself may deliver cash value growth equal to the annual S&P 500 return (minus policy expenses); a rider, if purchased, may guarantee that the cash value will have grown to some minimum value each period. When the buildup phase concludes, the new cash value of the policy will be the maximum of the S&P 500 return (net of policy expenses) or the rider's guaranteed minimum return. The rider has therefore given the policyholder the option to choose between the S&P 500 return and the guaranteed minimum return. The price set to purchase the rider reflects the value of owning the option. As of year-end 2012, 38 percent of variable annuities had riders attached.[30] As of 2012, 54.5 percent of the industry's aggregate annuity reserves and 32.7 percent of its total reserves were for variable annuities (see table 1, p. 51).

Deposit-type products

As of 2012, 8.8 percent of the life insurance industry's total reserves were for deposit-type products (see table 1, p. 51). These products include guaranteed investment contracts and funding agreements and are primarily sold to institutional clients rather than individual clients. They function similarly to bank certificates of deposit—policyholders purchase the contracts (that is, make "deposits") and receive interest and principal repayment in the future. Deposit-type contracts are purely savings vehicles; they do not contain a protection element.

Interest rate risk and embedded guarantees

Many of the products sold by life insurance companies are sensitive to changes in interest rates. Consider a whole life policy, in which the policyholder makes a set of fixed payments over time in exchange for the delivery of a larger fixed payment in the future. Changes in interest rates alter the expected value today of such future payments. Specifically, a decrease in interest rates causes future payments to carry more weight and thus makes a life insurance company's liabilities larger in magnitude. This is a key form of interest rate risk that must be managed by the life insurance industry.

Assessing the interest rate risk of a life insurer's liabilities is not always straightforward. One complicating factor is that many of the products offered by life insurers have guarantees, either embedded in the policies or attached as riders. The most common guarantees credit a minimum periodic rate of return to the policy cash value, ensuring that the cash value will grow by at least some minimum percentage each period. Minimum guarantees are typically specified when policies are sold. The guarantees are said to be either in the money or out of the money depending on how the guaranteed return compares with the return that would exist if not for the guarantee. This may be easiest to see for variable annuities. If the guaranteed return on a variable annuity exceeds the return from the policyholder's investments, the insurer funds the difference using its own assets. Therefore, the guarantee is in the money.

Typically, minimum return guarantees are set below market interest rates when policies are sold. In that sense, they are like an option that is out of the money. When interest rates fall and remain low, however, the option can become in the money, and the guarantees can lead life insurers to lose money. In 2010, nearly 95 percent of all life insurance policies contained a minimum interest rate guarantee of 3 percent or higher.[31] Also, in that year, among the annuity contracts with a rate guarantee, nearly 70 percent had a minimum of 3 percent or higher.[32] Given that the ten-year Treasury bond interest rate, which is indicative of prevailing long-term interest rates, is now running close to or below 3 percent, life insurers are crediting the majority of their life insurance and fixed annuity policies at the guaranteed rate rather than the current market rate.

Another complication in assessing the interest rate risk of the life insurance industry's liabilities is that many of the liabilities offer options to policyholders. Minimum return guarantees act as embedded financial options for policyholders. When a guarantee is in the money (that is, when the guarantee generates a higher return for the policyholder than other possible investments), the policyholder has an incentive to deposit additional funds into the policy (for example, by contributing more to a policy that allows flexible premiums) or to limit cash withdrawals from the policy (for example, by limiting policy surrenders). Thus, the life insurer may face additional liabilities and/or a lesser runoff of liabilities precisely when the liabilities are least desirable to the insurer. Of course, not all policyholders exercise their embedded options optimally. However, historical data show that policyholders tend to adjust their behavior in accordance with the embedded guarantees available in their policies. For example, individuals increase withdrawals from fixed deferred annuities when interest rates rise and decrease withdrawals from them when interest rates fall.[33] Therefore, policyholder behavior tends to magnify the degree to which minimum return guarantees expose the life insurers to interest rate risk.

Life insurance company assets and derivatives

Asset–liability management plays a large role at life insurance companies. When life insurers take in premiums from issued policies, they must balance the drive to earn high returns with the desire to appropriately hedge risks. Achieving this balance is further complicated by insurance regulations that impose restrictions on investments. For example, a common regulation requires life insurers to hold more capital when they invest in riskier assets. This regulation and others that limit the amount of risk in life insurance investment portfolios have led life insurers to set up a segregated section on their balance sheets—called the separate account—to hold variable annuities and other variable products providing protection, along with the assets that back them. All other assets and liabilities are tracked in what is referred to as the general account. Regulators permit life insurers to hold assets in the separate account that would normally be deemed too risky for the general account. This is because separate-account assets exclusively back separate-account liabilities, which pass through asset returns directly to the policyholders and thus limit the life insurers' exposure to asset-related risks. We discuss the assets in life insurance companies' general and separate accounts separately.

General-account assets

Life insurance companies take on liabilities in their general accounts by issuing insurance and annuity policies with obligations that are fixed in size. To hedge the liabilities from these products, life insurers tend to invest in fixed-income securities (that is, bonds). Table 2 shows that 74.8 percent of life insurers' general-account assets in 2012 were bonds. Upon closer examination of the bond portfolio, one can see that insurers hold various classes of bonds that spread across the risk spectrum—from Treasury bonds, which are conservative investments, to nonagency (private label) mortgage-backed securities (MBS), which are relatively more aggressive ones. Corporate bonds made up the largest share of the bond portfolio; at year-end 2012, life insurers held $1.5 trillion in corporate bonds, and these bonds accounted for 44.2 percent of the aggregate general account's invested assets. In addition, because of the long-term nature of most general-account obligations, life insurance companies tend to purchase fixed-income securities with fairly long maturities. This investment concept of matching the duration of assets to the duration of liabilities is known as asset–liability matching and is intended to limit companies' exposure to interest rate risk. The weighted average maturity of the life insurance industry's aggregate bond portfolio is 10.2 years. We do not have a comparable value for the duration of life insurers' liabilities, so we examine the asset–liability match indirectly later in this article.

In addition to bonds, life insurance companies hold several other types of investments. Mortgages account for 9.9 percent of the industry's general account's

TABLE 2

Life insurance industry's aggregate assets, 2012

	General-account (GA) assets			Separate-account (SA) assets	
	Billions of dollars	Percentage of GA investments	Weighted average maturity (years)	Billions of dollars	Percentage of SA investments
Bonds	2,545.4	74.8	10.2	292.3	14.5
Treasury and federal government bonds	177.8	5.2	11.9	—	—
State and municipal bonds	125.8	3.7	14.3	—	—
Foreign government bonds	75.8	2.2	13.4	—	—
Agency mortgage-backed securities	229.6	6.7	10.0	—	—
Nonagency mortgage-backed securities	237.5	7.0	6.8	—	—
Asset-backed securities	170.9	5.0	9.1	—	—
Corporate bonds	1,504.4	44.2	10.1	—	—
Affiliated bonds	23.6	0.7	5.9	—	—
Equities	77.4	2.3	—	1,620.1	80.4
Mortgages	335.3	9.9	—	8.5	0.4
Real estate	21.3	0.6	—	7.6	0.4
Policy loans	127.5	3.7	—	0.5	0.0
Cash and short-term investments	106.4	3.1	—	18.1	0.9
Derivatives	41.6	1.2	—	0.7	0.0
Other investments	149.2	4.4	—	67.5	3.4
Total investments	3,404.1	100.0	—	2,015.3	100.0
Total assets	3,590.0	—	—	2,053.2	—

Notes: All values are for year-end 2012. Agency refers to a U.S. government-sponsored agency, such as the Federal National Mortgage Association (Fannie Mae) and Federal Home Loan Mortgage Corporation (Freddie Mac). Policy loans are loans originated to policyholders that are financed by cash that has accrued in their policies. The percentages of various bond classes in the general account do not total to the overall percentage of bonds because of rounding. Total assets also comprise reinsurance recoverables, premiums due, and other receivables (not listed).

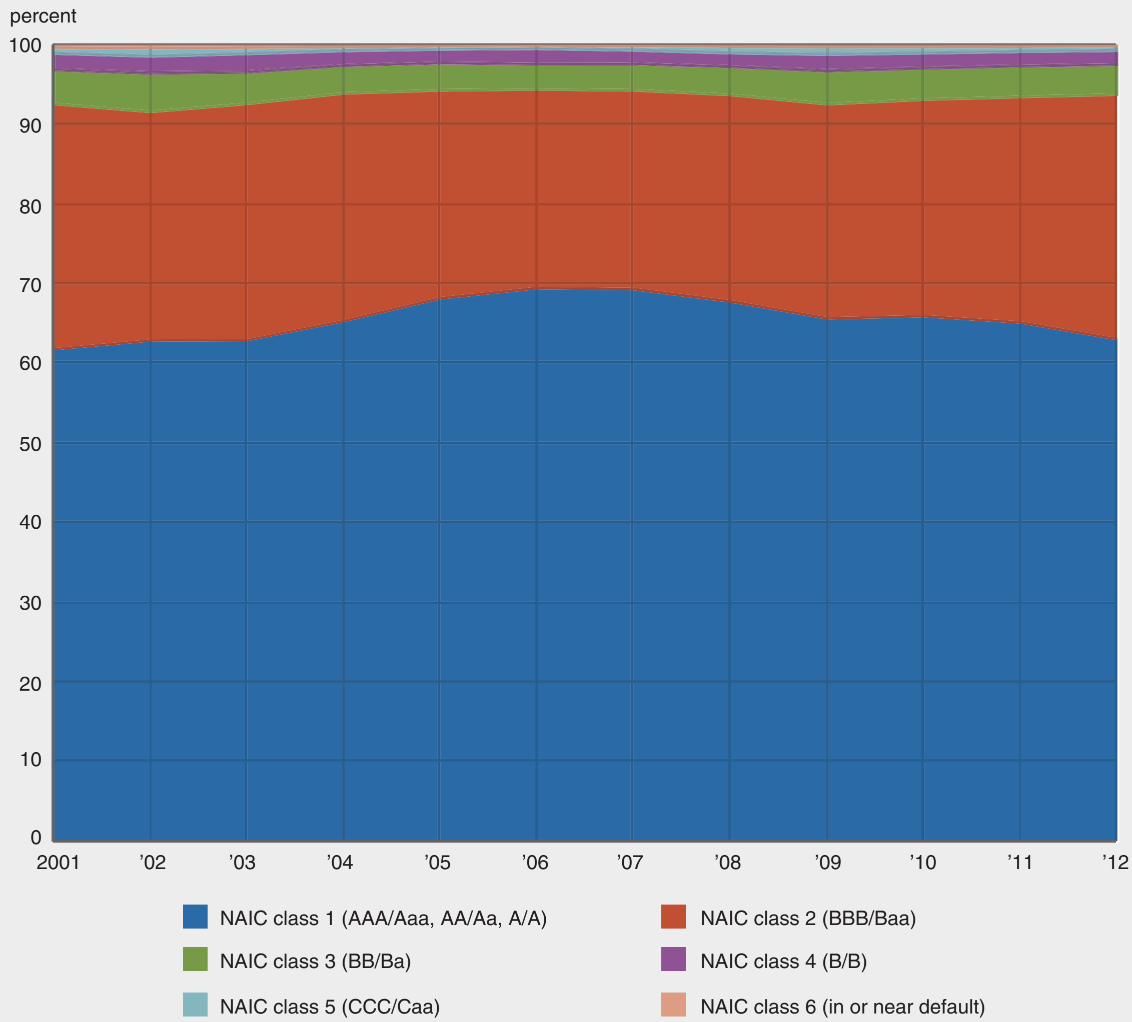
Source: Authors' calculations based on data from SNL Financial.

invested assets (table 2). Mortgages function similarly to fixed-income securities (such as bonds); and as such, mortgages are also sensitive to the interest rate environment. The rest of the life insurance industry's aggregate investment portfolio is made up of equities, real estate, policy loans, cash and short-term investments, derivatives, and other investments.[34] Together, these assets represent just 15.3 percent of the industry's general-account investment holdings.

As mentioned previously, regulators have created a system that reduces the incentive for life insurers to hold excessively risky assets in their general-account portfolios. While asset–liability matching mitigates interest rate risk, life insurers are still subject to credit risk on their asset portfolios (that is, the risk that assets may lose value over time). To mitigate the impact of credit risk on the financial solvency of life insurers, state insurance regulators have imposed what are known as risk-based capital (RBC) requirements. RBC requirements establish a minimum acceptable level of capital that a life insurer is required to hold. The level is a function of the quality of a company's asset holdings, along with interest rate risk, insurance/underwriting risk, general business risk, and affiliated asset risks.[35] The level is set such that a company would be able to pay its insurance liabilities during highly unlikely and adverse outcomes.[36] Insurance companies that do not maintain adequate levels of risk-based capital may be subject to additional regulatory scrutiny or even mandatory seizure by the state insurance commissioner. To measure asset quality, the National Association of Insurance Commissioners (NAIC) has developed a methodology that categorizes most assets held by life insurers into six classes. A breakdown of the six classes for bonds—which represent the life insurance industry's largest asset holdings—is depicted in figure 3. Class 1 bonds—which correspond to securities rated AAA, AA, and A—have the least credit risk and therefore require insurers to hold a very small amount of risk-based capital (0.4 percent of book value).[37] On the opposite end of the spectrum, class 6 bonds are defined as being in or near default and require insurers to hold large amounts of risk-based capital (30 percent of book value).[38] The RBC system instituted by state insurance

FIGURE 3

Life insurance industry's aggregate bond holdings, by NAIC class



Notes: NAIC classes (1–6) are the National Association of Insurance Commissioners divisions of bonds for the purposes of capital regulation. The Standard & Poor's and Moody's credit rating association with each NAIC class is in parentheses.
Sources: Authors' calculations based on data from Bennett (2009) and SNL Financial.

regulators is therefore intended to protect the financial solvency of life insurers by requiring them to balance the level of credit risk in their portfolios with a corresponding level of supporting capital.[39]

Separate-account assets

As mentioned earlier, the assets that support variable annuities and some variable life insurance policies are housed in life insurers' separate accounts. The asset composition of the separate account is materially different from that of the general account. In 2012, equities made up 80.4 percent of separate-account assets, whereas they made up just 2.3 percent of general-account assets (see table 2, p. 56). This is because a significant portion of separate-account liabilities deliver returns that are linked to equity markets. So, for example, if a variable annuity policyholder is promised a return linked to that of the S&P 500, the insurer would be required to hold exposure to the S&P 500 in its separate account. Bonds, meanwhile, make up only 14.5 percent of separate-account invested assets, and mortgage loans make up 0.4 percent. The asset composition of the separate account is remarkably different than that of the general account, which primarily holds fixed-income assets.

On the surface, it may appear that life insurance companies are not exposed to any residual risk from their separate-account asset holdings. This is because returns from separate-account assets are generally passed on to the policyholders. However, there is one complication. As noted earlier, many variable annuities are sold with riders that promise a minimum return.[40] Several types of riders may be purchased, but they all fulfill the common function of guaranteeing a minimum rate of growth on the policy's cash value. For example, a typical rider might promise that the cash value of an annuity policy will grow by some minimum percentage each year, irrespective of the actual returns on policy assets. This presents a problem for life insurance companies because the variable annuity riders' guarantees are backed by the insurer's own assets. Therefore, they constitute an investment risk faced by the insurer; if the insurer cannot generate sufficient investment income to satisfy the guarantees, it must fund the guarantees using surplus capital. As such, variable annuity riders' guarantees are recorded as liabilities in the general account. This is in contrast to the variable annuities themselves, which are backed by assets that are stored in the separate account. Variable annuity riders' guarantees are currently a significant issue for the life insurance industry because of the weakness of equity market returns since 2000 and today's environment of low interest rates.

Derivatives

Life insurers rely not only on their asset portfolios but also on derivatives to manage interest rate risk that arises from the long-term nature of their liabilities. Derivatives have traditionally not played a large role in risk management in the life insurance industry. The notional value of derivatives equals 44 percent of general-account invested assets, or $1.5 trillion.[41] However, this value overstates the net impact of derivatives, since life insurers appear to take offsetting positions with their derivative holdings. Interest rate swaps—the most common type of derivative used by life insurers—illustrate this point. Interest rate swaps are used to hedge interest rate risk.[42] Interest rate swaps make up 48 percent of total derivatives by notional value.[43] Under an interest rate swap agreement, one party promises to make periodic payments that float according to an interest rate index, such as the Libor (London interbank offered rate), while the other party promises to make periodic fixed payments. As shown in figure 4, life insurers are more likely to pay at the floating rate, but the net floating position is generally less than 10 percent of the total notional value.[44]

Life insurers are also actively involved in other types of interest rate derivatives as well. Interest-rate-related derivative products are particularly attractive to life insurers because they help hedge common risks faced by the companies. For example, life insurers set premiums for whole life policies at the inception of the policies. To set a premium, insurers must forecast returns on premiums that will be received years—and even decades—later. However, these returns may vary with then-current interest rates. Interest-rate-related derivatives are well designed to hedge against this risk. One advantage of using derivatives for this task is that derivatives such as forward-starting swaps—which allow life insurers to hedge changes in interest rates for money they receive in the future—typically do not require payments at contract initiation.

Interest rate risk

As we have explained in the previous section, an important part of running a life insurance firm is managing interest rate risk. Changes in interest rates can affect the expected value of insurance liabilities significantly, and the impact may be so complex that it is very difficult to estimate. In general, life insurers can manage interest rate risk by matching the cash flows of assets and liabilities. However, they also have to consider interest rate risk from the embedded options in many products that they sell. Insurers can use derivatives to hedge some of the option risk, but the use of derivatives can be expensive. There is the possibility that life insurers find it optimal to leave themselves open to some interest rate risk. This risk may be more apparent when interest rates move by an unexpectedly large amount, as has happened in the past few years. In this section, we explore whether life insurers are, on net, exposed to interest rate risk—and if so, to what degree.

Interest rate risk at life insurance firms

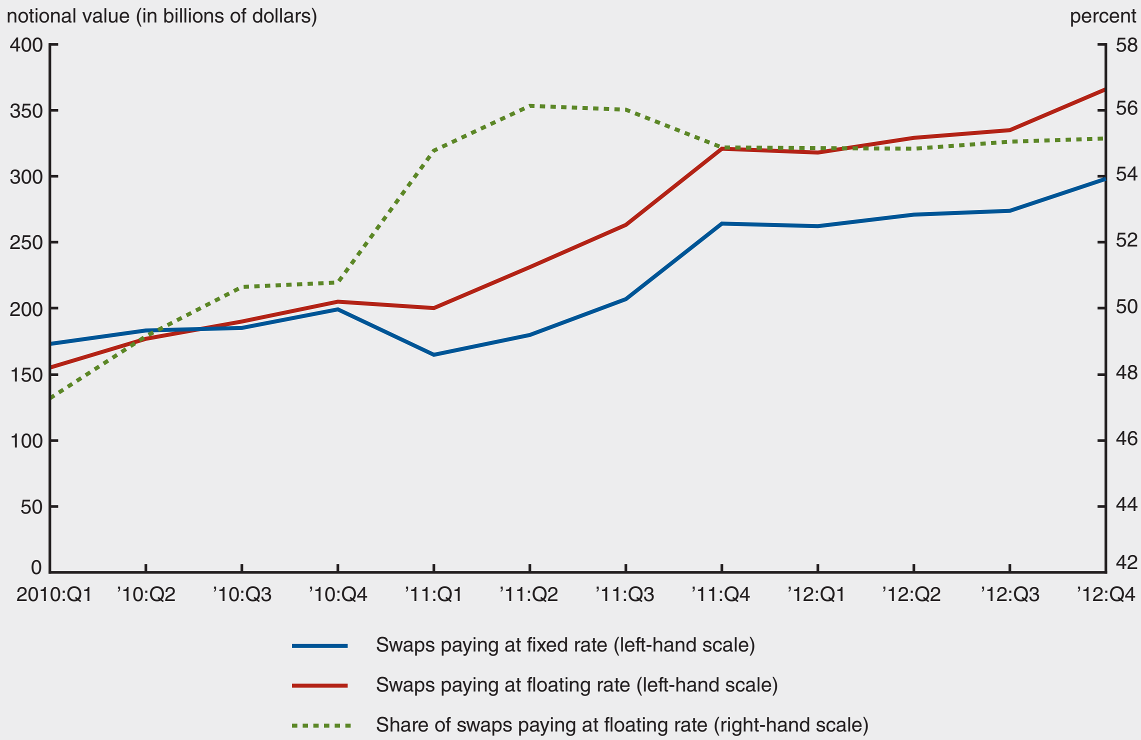
We are not able to directly measure the interest rate risk that a life insurance firm faces from the publicly available balance-sheet information. Insurers report rather detailed information on their assets but more-limited information on their liabilities.

To examine interest rate risk, we use life insurers' stock price information instead of their publicly available balance-sheet information. The correlation between changes in an insurer's stock price and changes in interest rates is an estimate of the interest rate risk faced by the firm. Changes in interest rates affect a firm's stock price both because they affect the value of the firm's existing balance sheet and because they affect future profit opportunities for the firm. We account for both impacts when discussing the interest rate sensitivity of a life insurer.

We use a two-factor market model to estimate the interest rate risk of insurance firms. We assume that

FIGURE 4

Life insurance industry's interest rate swaps that pay at floating rate



Note: The data are restricted to swap instruments with open positions as of December 31, 2012, indicated as being used to hedge interest rate risk on life insurance firms' quarterly financial statements for the fourth quarter of 2012 (2012:Q4).
Source: Authors' calculations based on data from SNL Financial.

the return on the stock of life insurance firm j (at the corporate parent level) is described by the following:

1) $R_{j,t} = \alpha + \beta R_{m,t} + \gamma R_{10,t} + \varepsilon_t$,

where

$R_{j,t}$ = the return (including dividends) on the stock of firm j in week t,

$R_{m,t}$ = the return on a value-weighted stock market portfolio in week t,

$R_{10,t}$ = the return on a Treasury bond with a ten-year constant maturity in week t, and

ε_t is a mean zero error term.[45]

In this model, we estimate the coefficients α, β, and γ. Two-factor models of this sort have been used to estimate the interest rate risk of insurance firms (for example, Brewer, Mondschean, and Strahan, 1993) and other financial intermediaries (for example, Flannery and James, 1984). One issue with this approach is that we care about the coefficient γ, but estimates of γ for individual firms are often not statistically significantly different from zero. For that reason, we also run our baseline analysis using the two-factor model (equation 1) for a value-weighted portfolio of all firms so that firm j is the portfolio of all firms in the sample. The value-weighted portfolio has less idiosyncratic noise.

One advantageous feature of a stock-price-based measure is that we can use higher-frequency data (here, we use weekly stock price changes rather than quarterly or annual balance-sheet information). This gives our tests of interest rate sensitivity more power. However, there are several drawbacks to using stock price data as the basis for interest rate risk measures. One drawback is that stock prices are at the corporate parent level rather than at the insurance company level. Many firms that own life insurance companies also own other non-life-insurance subsidiaries (henceforth, we use "firm" to refer to a life insurer at the corporate parent level and "company" for the life insurance operating subsidiary). For the most part, we do not have detailed data for non-life-insurance subsidiaries, so we do not know the extent to which the non-life-insurance subsidiaries contribute to interest rate risk at the corporate parents (and we

TABLE 3

Life insurance firms in the sample

Firm	Stock ticker	Total assets (billions of dollars in December 2012)	First month in sample
Aflac Inc.	AFL	131.09	August 2002
American Equity Investment Life Holding Co.	AEL	35.13	December 2003
American National Insurance	ANAT	23.11	August 2002
Ameriprise Financial Inc.	AMP	134.73	October 2005
Assurant Inc.	AIZ	28.95	February 2004
CNO Financial Group Inc.	CNO	1.17	September 2003
Citizens Inc.	CIA	34.13	August 2002
Genworth Financial Inc.	GNW	113.31	June 2004
Hartford Financial Services Group Inc.	HIG	298.51	August 2002
Kansas City Life Insurance Co.	KCLI	4.53	August 2002
Kemper Corp.	KMPR	8.01	August 2002
Lincoln National Corp.	LNC	218.87	August 2002
Manulife Financial Corp.	MFC	486.06	August 2002
MetLife Inc.	MET	836.78	August 2002
National Western Life Insurance Co.	NWLI	10.17	August 2002
Phoenix Companies Inc.	PNX	21.44	August 2002
Principal Financial Group Inc.	PFG	161.93	August 2002
Protective Life Corp.	PL	57.38	August 2002
Prudential Financial Inc.	PRU	709.30	August 2002
Reinsurance Group of America Inc.	RGA	40.36	August 2002
Scottish Re Group Ltd.	SKRRF	—	August 2002
Security National Financial Corp.	SNFCA	0.60	August 2002
StanCorp Financial Group Inc.	SFG	19.79	August 2002
Sun Life Financial Inc.	SLF	225.78	August 2002
Torchmark Corp.	TMK	18.78	August 2002
Unum Group	UNM	62.24	August 2002

Notes: All firms except the Scottish Re Group Ltd. remain in the sample through the end of December 2012. Scottish Re Group Ltd. falls out of the sample after March 2008.
Sources: Compustat and SNL Financial.

cannot control for whether the interest rate risk of life insurers is hedged elsewhere within a corporate structure). In addition, life insurers that are organized as mutual insurance companies do not have traded stock and are, therefore, not included in our analysis.

Our sample comprises firms that SNL Financial classifies as those primarily engaged in the life insurance business (whether directly themselves or through their subsidiaries).[46] We examine life insurance firm stock returns from August 2002 through December 2012. To be included in our sample, a firm must have data for at least 250 weeks. The final sample has 26 firms and 12,955 firm-week observations (see table 3 for a list of the firms).[47] Table 4 gives summary statistics for the sample firms. On average, stock returns for the life insurance firms in our sample were 27.6 basis points per week (15.4 percent per year[48]) compared with a market return of 16.2 basis points per week (8.8 percent per year). Over the same period, the average risk-free rate (the one-month Treasury bill rate) was 3.4 basis points per week (1.8 percent per year) and the average return on a ten-year Treasury bond was 12.7 basis points per week (6.8 percent per year). Note that the return on the Treasury bond includes capital appreciation plus interest payments.[49]

Table 5 presents the coefficient estimates for a regression of equation 1. The first two columns of data present the results of the individual firm regressions. The median estimate of γ is 0.370, meaning that the return on the median life insurance firm's stock increases by 0.370 percentage points for every one percentage point increase in the return on a ten-year Treasury bond, all else being equal. This effect is economically large: A one standard deviation increase in the ten-year Treasury bond return (109.7 basis points, as shown in table 4) induces a 40.6 basis point increase in the stock return, which is approximately twice as large as the median stock return (19.0 basis points, as shown in table 4). The results are similar when we look at the mean γ coefficient from the individual-firm regressions (first

TABLE 4

Summary statistics for life insurance firms in the sample

	Mean	Median	Standard deviation
Firm stock return ($R_{j,t}$)	0.276	0.190	7.413
Memo: Bank stock return	0.107	0.000	6.909
Memo: Property and casualty insurer stock return	0.255	0.125	5.236
Market return ($R_{m,t}$)	0.162	0.243	2.655
Risk-free rate (RF_t)	0.034	0.022	0.036
Ten-year Treasury bond total return ($R_{10,t}$)	0.127	0.161	1.097
Memo: Ten-year Treasury bond yield	3.681	3.930	0.944
Total assets (billions of dollars)	106.423	29.258	153.659
Ln(total assets)	3.495	3.376	1.818
Life insurance subsidiaries' assets/total assets	73.4	77.9	18.2
Property and casualty insurance subsidiaries' assets/total assets	3.6	0.0	8.8
Noninsurance subsidiaries' assets/total assets	23.3	19.6	16.9
Interest-rate-sensitive liabilities/general-account liabilities	11.7	11.6	11.0
Separate-account liabilities/life insurance assets	20.8	14.0	23.4
Life insurance liabilities/(life insurance liabilities + annuity liabilities)	52.2	50.9	29.2

Notes: All values are in percent unless otherwise indicated. Firms refer to life insurers at the corporate parent level. The firm stock return data are based on weekly returns averaged across all sample observations (26 firms over 525 weeks in an unbalanced panel, for a total of 12,955 observations). Other return and yield data are based on one observation per week for the sample period (525 weeks). Balance-sheet information is based on one observation per quarter per firm (26 firms over 42 quarters in an unbalanced panel, for a total of 1,038 observations). Banks comprise all firms that are U.S. commercial banks or own such a bank except firms that are foreign owned or primarily do nonbanking activities. Property and casualty insurers are those classified as such by SNL Financial.

Sources: Authors' calculations based on data from Compustat; French (2013); Haver Analytics; SNL Financial; and CRSP®, Center for Research in Security Prices, Booth School of Business, The University of Chicago (used with permission; all rights reserved; www.crsp.uchicago.edu).

column of table 5) or the estimated γ from the aggregate portfolio regression (third column of table 5).

The regression results in table 5 imply that life insurers' stock prices increase when interest rates decrease. This is because, as the positive value of γ in table 5 indicates, stock returns increase when Treasury bond returns increase. We know that when interest rates decrease, the return on a Treasury bond is positive. As we will see, however, this result in table 5 is misleading.

The sample period—August 2002 through December 2012—includes very different environments for life insurance firms. The early part of the sample period was in the "Great Moderation."[50] During this early part of the sample period, markets perceived the economy to be very safe, and defaults on fixed-income investments were low. However, a financial crisis began in late 2007 and continued at least into 2009. During the crisis, regulators and legislators in the United States and elsewhere intervened in financial markets to help resolve the crisis. To help address the crisis, the Federal Reserve had cut short-term interest rates to essentially zero by 2009 and took several other unconventional measures. By the later part of the sample period, long-term rates were at their lowest levels in

TABLE 5

Baseline regression results

	Firm-level regressions		Portfolio regression	
	Mean coefficient	Median coefficient	Coefficient	*p*-value
γ	0.366	0.370	0.284	0.278**
β	1.544	1.425	0.464	1.652***
α (constant)	−0.067	−0.004	0.222	0.029

** Significant at the 5 percent level.
*** Significant at the 1 percent level.
Notes: The regressions take the following form:

$$R_{j,t} = \alpha + \beta R_{m,t} + \gamma R_{10,t} + \varepsilon_t,$$

where $R_{j,t}$ = the return (including dividends) on the stock of firm j in week t, $R_{m,t}$ = the return on a value-weighted stock market portfolio in week t, $R_{10,t}$ = the return on a Treasury bond with a ten-year constant maturity in week t, and ε_t is a mean zero error term. The firm-level regression results are based on one regression for each of the 26 sample firms for all observations in the sample period. The portfolio regression is for an aggregate portfolio for all 26 firms in the sample over the entire sample period (525 observations; R-squared of 0.681).

Sources: Authors' calculations based on data from Compustat; French (2013); Haver Analytics; SNL Financial; and CRSP®, Center for Research in Security Prices, Booth School of Business, The University of Chicago (used with permission; all rights reserved; www.crsp.uchicago.edu).

over 50 years. Several financial firms, including insurers Hartford Financial Services Group Inc. and Lincoln National Corp., received funds from the Troubled Asset Relief Program (TARP), and American International Group Inc. (AIG) was recapitalized with $180 billion provided by the Federal Reserve and the U.S. Treasury Department.[51] We examine whether the interest rate sensitivity of life insurance firms differed in the three environments in our sample. We use August 2002 through July 2007 as the baseline period and call it the pre-crisis period. We consider August 2007 through July 2010 to be the crisis period. Finally, August 2010 through December 2012 is what we call the low-rate period. While economic growth was weak during much of this low-rate period, many of the interventions of the financial crisis had been removed. A primary factor affecting life insurance companies during that time was the historically low level of interest rates.

Table 6 presents the results of regressions for each of the three periods. Panel A presents the coefficients for the individual firm regressions, and panel B presents the coefficients for the portfolio regressions. The results in the two panels are qualitatively similar. It is apparent from table 6 that the financial crisis period was very different from the pre-crisis and low-rate periods, as indicated by the γ coefficients. The γ coefficients reported in table 5 (p. 61) are positive because of the crisis period results (the γ coefficients during the crisis period in table 6 are the only ones that are positive). We do not consider the estimates based on the crisis sample to be very informative because during the crisis period changes in interest rates occurred at the same time as interventions by regulators and legislators, which we do not take into account in the factor regressions. Henceforth, we devote our attention chiefly to the pre-crisis and low-rate periods.

Excluding the crisis period, we find that there is a negative relationship between the returns on Treasury bonds and the returns on life insurance firm stocks. But even so, we have to be careful because our sample contains a wide variety of life insurance firms. Some firms have significant noninsurance activities, while others do not. Among the life insurance operating subsidiaries, some companies focus more on annuities than others. Only about one-half of the firms have more than minimal separate-account liabilities. Many of these differences line up with firm size, so we divide the sample by total assets to see how interest rate sensitivity varies by firm size. We consider a life insurance firm to be large if it has at least $100 billion in assets at the end of 2012. All other firms are considered to be small. So, by this criterion, the large firms are the ten largest life insurance firms by total assets at the end of 2012 in the sample (table 3, p. 60), and the small firms are the remaining 16 life insurers.

TABLE 6

Regression results, by time period

A. Firm-level regressions

		Pre-crisis	Crisis	Low-rate
γ	Mean	−0.020	0.888	−0.195
	Median	−0.076	0.740	−0.196
β	Mean	0.898	1.932	1.251
	Median	0.841	1.711	1.250
α (constant)	Mean	0.064	−0.038	−0.099
	Median	0.082	0.233	−0.088

B. Portfolio regressions

	Pre-crisis	Crisis	Low-rate
γ	−0.084	0.760**	−0.481***
	(0.082)	(0.309)	(0.174)
β	0.913***	1.997***	1.376***
	(0.042)	(0.108)	(0.080)
α (constant)	0.184**	0.335	−0.132
	(0.073)	(0.381)	(0.152)
Observations	252	150	123
R-squared	0.684	0.716	0.839

** Significant at the 5 percent level.
*** Significant at the 1 percent level.
Notes: The regressions take the following form:

$$R_{j,t} = \alpha + \beta R_{m,t} + \gamma R_{10,t} + \varepsilon_t,$$

where $R_{j,t}$ = the return (including dividends) on the stock of firm j in week t, $R_{m,t}$ = the return on a value-weighted stock market portfolio in week t, $R_{10,t}$ = the return on a Treasury bond with a ten-year constant maturity in week t, and ε_t is a mean zero error term. The pre-crisis period is August 2002 through July 2007. The crisis period is August 2007 through July 2010. The low-rate period is August 2010 through December 2012. In panel A, the firm-level regression results are based on one regression for each of the 26 life insurance firms in the sample (table 3, p. 60). In panel B, the portfolio regression is for an aggregate portfolio for all 26 firms in the sample, and the standard errors are in parentheses.
Sources: Authors' calculations based on data from Compustat; French (2013); Haver Analytics; SNL Financial; and CRSP®, Center for Research in Security Prices, Booth School of Business, The University of Chicago (used with permission; all rights reserved; www.crsp.uchicago.edu).

Table 7 presents summary statistics for the sample by firm size during the pre-crisis, crisis, and low-rate periods. The large firms in the sample are much larger than the small firms, reflecting how concentrated the life insurance industry is (see fifth row of data). The large firms have more noninsurance business than small firms (ninth row). Overall, large firms have a greater share of their general-account liabilities being interest-rate-sensitive than small firms (tenth row). Large firms also are much more likely to have separate accounts than small firms (11th row). Finally, large firms' life insurance subsidiaries have fewer life insurance liabilities than annuity liabilities, while small firms' life insurance subsidiaries have more life insurance liabilities than annuity liabilities (final row).

To see whether interest rate sensitivity is different for large and small life insurance firms, we run the baseline regressions for large firms and small firms separately and present the results in table 8. The stock prices of small firms react differently to changes in the value of ten-year Treasury bonds than do the stock prices of large firms. At the firm level, the stock returns of a small life insurance firm and bond returns are generally positively correlated, albeit only slightly. The median values of γ for small life insurance firms are 0.070 in the pre-crisis period and –0.049 in the low-rate period (panel A of table 8). Contrast these results with the results for large firms: The median values of γ are –0.105 in the pre-crisis period and –0.414 in the low-rate period. To test whether γ is negatively correlated with firm size, we regress γ on the natural log of firm size. The negative coefficients on ln(total assets) in the pre-crisis and low-rate periods in the regressions in panel B of table 8 imply that γ decreases (becomes less positive or more negative) as firm size grows, all else being equal. The negative relationship between firm size and interest rate sensitivity is confirmed in the aggregate portfolio regressions (panel C of table 8). The γ coefficients in the large firm regressions are less than those in the small firm regressions in both the pre-crisis and low-rate periods. In the low-rate period, the difference between the interest rate sensitivity of large firms and that of small firms is statistically significantly different from zero (not shown in table 8). Overall, the results suggest that large firms' risk exposures were roughly balanced in the pre-crisis period, but that large firms have a high negative exposure to ten-year Treasury bond returns in the low-rate period. For small firms, the risk exposures are close to being balanced in both the pre-crisis and low-rate periods. We discuss possible reasons for the differences across firms later.

We can use the results in table 8 to estimate the net interest rate risk exposure of life insurance firms in two different ways. The first is by the estimated duration of a life insurance firm. The duration of a firm is a measure of how long it will be until cash flows are received (a positive duration) or paid (a negative duration).[52] A security's duration (D) is sufficient to estimate the approximate change in value of that security when interest rates change by a small amount:

$$2)\qquad \frac{\Delta P}{P} \approx -D \times \frac{\Delta R}{(1+R)},$$

where P is the price of the security and R is the interest rate. Since $\Delta P/P$ is the return on the security, we can use this formula to get an estimate of the duration of a life insurance firm as a whole by viewing the firm as a security. Essentially, the estimated duration of a life insurance firm is roughly equal to the duration of a ten-year Treasury bond multiplied by γ. Since the duration of a ten-year Treasury bond was approximately 8.0 years, the average duration of a large insurance firm was –0.70 years in the pre-crisis period.[53] In the low-rate period, the duration of a ten-year Treasury bond was approximately 8.9 years, so the average duration of a large insurance firm was –4.91 years.[54] A negative duration is the same as being short an asset or owning a liability. So, if an insurance firm has a duration of –0.70 years, it means that its stock changes in value proportionately to the changes in value of a liability with a duration of 0.70 years. To interpret what a negative duration means, remember that (changes in) interest rates affect both the return on a firm's existing portfolio and its future business prospects. A negative duration implies either that the duration of a firm's liabilities is longer than that of its assets or that when interest rates increase, the firm's future business prospects get better.

We can also estimate the impact of a change in Treasury bond interest rates on life insurer stock prices. An increase in the ten-year Treasury bond interest rate of 100 basis points is associated with a 0.70 percent increase in life insurer stock prices in the pre-crisis period and a 4.6 percent increase in the low-rate period.[55] Thus, the market viewed life insurers as roughly hedged against interest rate risk in the pre-crisis period. This was not true in the low-rate period, where the interest rate sensitivity is consistent with liabilities lengthening relative to assets (as interest rates decreased) and with low rates reducing profit opportunities.

Changes in interest rate risk during low-rate period

For most of the low-rate period (August 2010 through December 2012), interest rates were lower than their levels from the mid-1950s through the end of the crisis period (July 2010). Not only was the federal funds rate below 0.25 percent per year during the

TABLE 7

Mean values for selected variables, by firm size and time period

	Pre-crisis			Crisis			Low-rate		
	Small firms	Large firms	Difference	Small firms	Large firms	Difference	Small firms	Large firms	Difference
Firm stock return ($R_{j,t}$)	0.207	0.404	0.198	0.240	0.435	0.196	0.281	0.124	−0.157
Market return ($R_{m,t}$)	0.254			−0.066			0.253		
Risk-free rate (RF_t)	0.056			0.025			0.001		
Ten-year Treasury bond total return ($R_{10,t}$)	0.085			0.194			0.129		
Total assets (billions of dollars)	16.185	208.074	191.889	19.005	255.796	236.791	22.990	307.917	284.928
Ln(total assets)	2.226	5.137	2.911	2.422	5.336	2.914	2.629	5.497	2.868
Life insurance subsidiaries' assets/total assets	73.8	75.8	2.0	72.2	73.5	1.3	74.3	68.9	−5.3
Property and casualty insurance subsidiaries' assets/total assets	4.0	3.7	−0.3	4.5	1.9	−2.6	3.9	1.6	−2.2
Noninsurance subsidiaries' assets/total assets	22.2	22.3	0.1	23.3	24.8	1.4	21.9	29.5	7.6
Interest-rate-sensitive liabilities/general-account liabilities	11.2	11.6	0.4	11.2	13.0	1.8	10.8	14.1	3.3
Separate-account liabilities/life insurance assets	6.6	40.7	34.1	7.1	43.7	36.6	7.3	47.0	39.7
Life insurance liabilities/ (life insurance liabilities + annuity liabilities)	56.6	46.3	−10.3	57.4	43.5	−13.9	55.6	45.5	−10.0

Notes: All values are in percent unless otherwise indicated. The large firms are the ten largest life insurance firms by total assets at the end of 2012 in the sample (table 3, p. 60), and the small firms are the remaining 16 life insurers. The firm stock return data are based on weekly returns averaged across all sample observations. Other return data are based on one observation per week for the sample period. Balance-sheet information is based on one observation per quarter per firm. The pre-crisis period is August 2002 through July 2007. The crisis period is August 2007 through July 2010. The low-rate period is August 2010 through December 2012. The difference is the large firm value minus the small firm value; some differences are not precise because of rounding.

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TABLE 8

Regression results, by firm size and time period

A. Firm-level regressions

		Small firms			Large firms		
		Pre-crisis	Crisis	Low-rate	Pre-crisis	Crisis	Low-rate
γ	Mean	0.033	0.865	−0.002	−0.096	0.899	−0.479
	Median	0.070	0.715	−0.049	−0.105	0.965	−0.414
β	Mean	0.825	1.717	1.079	1.013	2.249	1.505
	Median	0.753	1.570	0.987	0.921	2.340	1.523
α (constant)	Mean	−0.004	−0.284	−0.031	0.174	0.318	−0.183
	Median	0.025	0.152	−0.056	0.181	0.316	−0.125

B. Relationship between interest rate sensitivity and firm size

	Dependent variable					
	γ			β		
	Pre-crisis	Crisis	Low-rate	Pre-crisis	Crisis	Low-rate
Ln(total assets)	−0.032	0.043	−0.152***	0.052	0.197***	0.124**
	(0.022)	(0.108)	(0.047)	(0.036)	(0.063)	(0.044)
α (constant)	0.314	0.432	1.423**	0.368	−0.134	−0.075
	(0.231)	(1.144)	(0.513)	(0.380)	(0.663)	(0.479)
Observations	26	26	25	26	26	25
R-squared	0.081	0.006	0.308	0.077	0.292	0.255

C. Portfolio regressions

	Small firms			Large firms		
	Pre-crisis	Crisis	Low-rate	Pre-crisis	Crisis	Low-rate
γ	−0.073	0.738***	−0.100	−0.088	0.765**	−0.551***
	(0.089)	(0.229)	(0.122)	(0.086)	(0.331)	(0.191)
β	0.891***	1.611***	1.025***	0.920***	2.071***	1.444***
	(0.046)	(0.080)	(0.056)	(0.045)	(0.116)	(0.088)
α (constant)	0.079	0.249	−0.053	0.206***	0.350	−0.149
	(0.080)	(0.283)	(0.106)	(0.077)	(0.409)	(0.167)
Observations	252	150	123	252	150	123
R-squared	0.633	0.745	0.835	0.665	0.702	0.828

**Significant at the 5 percent level.
*** Significant at the 1 percent level.
Notes: The regressions in panels A and C take the following form:

$$R_{j,t} = \alpha + \beta R_{m,t} + \gamma R_{10,t} + \varepsilon_t,$$

where $R_{j,t}$ = the return (including dividends) on the stock of firm *j* in week *t*, $R_{m,t}$ = the return on a value-weighted stock market portfolio in week *t*, $R_{10,t}$ = the return on a Treasury bond with a ten-year constant maturity in week *t*, and ε_t is a mean zero error term. The large firms are the ten largest life insurance firms by total assets at the end of 2012 in the sample (table 3, p. 60), and the small firms are the remaining 16 life insurers. The pre-crisis period is August 2002 through July 2007. The crisis period is August 2007 through July 2010. The low-rate period is August 2010 through December 2012. The firm-level regression results are based on one regression for each of the 26 sample firms. In panel B, the dependent variable comes from the regression results summarized in panel A; each regression includes one observation for each firm in the sample. In panel C, the small firm portfolio regression is for an aggregate portfolio for all 16 small firms, and the large firm portfolio regression is for an aggregate portfolio for all ten large firms. In panels B and C, the standard errors are in parentheses.
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low-rate period, but also longer-term interest rates were at low levels. During the low-rate period, the ten-year Treasury bond interest rate averaged 2.36 percent—lower than in any month from the beginning of 1955 through the recent financial crisis years. Low interest rates pose challenges for life insurance companies because of the embedded guarantees we explained before, and low rates make it difficult for them to profit on products such as fixed annuities. Both factors lead us to two hypotheses, which we call H1 and H2. Although these hypotheses are about insurance operating companies, our tests are for their parent firms. Thus, it is implicit in both hypotheses that the effect of an interest rate change on an insurance company is reflected in the stock returns of its parent firm.

As discussed earlier, life insurance companies issue many products with embedded options. The options are often in the form of minimum guarantees, where the guarantees are generally set below market interest rates at the time the products are sold. When interest rates decrease substantially, these guarantees can become in the money. If an insurance company has not fully hedged against the decline, then the value of the company should be more sensitive to interest rate changes in the low-rate period. These changes in value would be in addition to any from mismatched assets and liabilities. In addition, as interest rates decrease, policyholders should be less likely to surrender their policies or otherwise access the cash value—which is equivalent to life insurers lengthening their liabilities.

All of these factors imply H1, which is as follows: *Life insurance firms should be more sensitive to interest rate changes in the low-rate period than in the pre-crisis period, all else being equal.*

Another way low interest rates can affect insurance companies is by making certain insurance products difficult to sell at a profit and at historical volumes. For example, when an insurance company sells a long-term fixed annuity, it often takes the funds and invests them in high-quality long-term bonds. The interest on the bonds is then used to fund the annuity and to pay the insurance company's expenses. When corporate bonds rated A are yielding about 3 percent, it is difficult for the company to offer the annuity investor a guaranteed return above 1 percent and still make a profit. Very few investors are willing to lock up their money in a long-term investment with a guaranteed return of less than 1 percent per year. This makes it hard for an insurance company to sell new long-term fixed-rate annuities. Because of this, we consider another hypothesis.

H2 is as follows: *The stock returns of life insurance firms should be lower in the low-rate period than in the pre-crisis period, all else being equal.*

Hypothesis H1 represents the effect of interest rates on the existing portfolio of an insurance firm, while H2 represents the effect of interest rates on the firm's future business prospects.

The results reported in table 8 allow us to test for differences between the pre-crisis period and the low-rate period. Low interest rates seem to have a greater effect on the stock returns of large insurance firms than on those of small insurance firms. For that reason, we go over the evidence for large firms first, and then discuss the results for small firms.

There is support for hypothesis H1 in the results for large life insurance firms. Interest rate sensitivity became increasingly negative from the pre-crisis period to the low-rate period for large life insurance firms. In the individual firm regressions, the median value of γ decreased from –0.105 in the pre-crisis period to –0.414 in the low-rate period (table 8, panel A). The portfolio regressions for large firms show a similar result, with γ decreasing from –0.088 in the pre-crisis period to –0.551 in the low-rate period (table 8, panel C). The decrease in γ from the pre-crisis period to the low-rate period (–0.463) is statistically significantly different from zero (table 9).

There is also support for hypothesis H2 in the large insurer results as the average level of stock market returns was less in the low-rate period than in the pre-crisis period. The first row of table 7 (p. 64) shows that the average return for large firms was 28 basis points per week lower in the low-rate period than it was in the pre-crisis period. But this may be due to lower returns for stocks as a whole rather than anything specific to life insurance firms. However, the weekly return for the stock market index was almost exactly the same during the low-rate period as it was in the pre-crisis period, which we use as our baseline. This suggests that the average return net of market factors was lower in the low-rate period. We can examine this further by analyzing our regression results. The expected return for a firm's stock, controlling for market effects, is

$$3)\quad \hat{\alpha} + \hat{\gamma}E(R_{10,t}) + E(RF_t),$$

where $\hat{\alpha}$ and $\hat{\gamma}$ are the estimated values of α and γ from equation 1 (p. 59), $R_{10,t}$ is the return on a ten-year constant maturity Treasury bond in week t, RF_t is the return on a three-month Treasury bill in week t, and E is the expectations operator. For large insurance firms, $\hat{\alpha}$ and $\hat{\gamma}$ are both lower in the low-rate period than in the pre-crisis period (table 9). The changes in the regression coefficients α and γ from the pre-crisis period to the low-rate period are statistically and economically significant.

For small life insurance firms, the picture is mixed. Small firms' stock returns were somewhat higher in the low-rate period than in the pre-crisis period (table 7, p. 64). The changes in the regression coefficients α and γ from the pre-crisis to the low-rate period are of a small magnitude and not statistically significant (table 9). On net, in part because the power of the tests is weak, there is no evidence that stock returns for small life insurance firms behaved differently in the low-rate period than they did in the pre-crisis period.

TABLE 9

Difference in regression coefficients in the pre-crisis and low-rate periods

	Small firms			Large firms		
	Firm-level regressions		Portfolio regressions	Firm-level regressions		Portfolio regressions
	Mean	Median		Mean	Median	
γ	−0.013	0.092	−0.020 (0.156)	−0.383	−0.396	−0.463** (0.183)
β	0.238	0.209	0.123* (0.075)	0.492	0.452	0.524*** (0.087)
α (constant)	−0.043	−0.065	−0.140 (0.137)	−0.357	−0.280	−0.355** (0.161)

*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Notes: This table presents the differences between the coefficients in regressions in the pre-crisis and low-rate periods (that is, the low-rate values minus pre-crisis values). The large firms are the ten largest life insurance firms by total assets at the end of 2012 in the sample (table 3, p. 60), and the small firms are the other life insurers in the sample *excluding* the Scottish Re Group Ltd. (unlike in all other tables). Scottish Re is not in the sample during the low-rate period and therefore is excluded entirely from the analysis presented in this table. The differences of both the firm-level mean regression coefficients and portfolio regression coefficients of large firms are computed based on the results reported in table 8. However, for both small and large firms, this table reports the medians of the differences of the firm-level regression coefficients, rather than the differences of the median coefficients reported in table 8. For the portfolio regressions, standard errors in parentheses are for tests of whether the coefficient differences are statistically significantly different from zero.

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Several previous studies have examined the sensitivity of life insurance firm stock returns to interest rate changes. Brewer, Mondschean, and Strahan (1993) examine the interest rate sensitivity of life insurance firm stock returns over the period 1972–91. They use a two-factor model like we do, but construct an equally weighted portfolio of life insurance firms rather than the value-weighted portfolio we use. In their analysis, bond returns were positively correlated with life insurer stock returns, although the relationship was statistically significant only for part of their sample. Their results are similar to our findings for small firms.[56] This is not surprising because life insurers in the 1970s and 1980s look more like the small insurers of today rather than the large insurers of today. There is also evidence that the interest rate sensitivity of life insurance firm stocks varies over time. A later study (Brewer et al., 2007) finds that interest rate sensitivities fell over time. Their equivalent of γ is 0.494 for 1975–78, 0.158 for 1979–82, and 0.054 for 1983–2000.[57]

Differences between large and small life insurance firms

We find that large life insurer stock returns have significantly more exposure to interest rate fluctuations than small life insurer stock returns. In this section, we explore possible explanations for the difference.

Compared with small life insurance firms, large life insurance firms have more interest-rate-sensitive liabilities and more noninsurance assets; additionally, large insurers are more likely to have separate-account liabilities than small life insurers. To see whether any of these firm characteristics explain the differences between large and small life insurers, we regress γ, our measure of interest rate sensitivity, on these variables and firm size. As shown in table 10, only firm size (that is, the natural log of total assets) has significant explanatory power.

This area is an interesting topic for future research.

Comparison to other financial intermediaries

To benchmark the interest rate risk at life insurance firms, we compare these firms with other financial intermediaries—specifically, banks and property and casualty (PC) insurers. Both banks and PC insurers have financial claims on both sides of their balance sheets, but the types of assets and liabilities they own differ from those owned by life insurers.

The banking industry occupies a central place in financial markets. Banks (specifically, private depository institutions) had $15.0 trillion in assets at the end of 2012.[58] Banks have less intrinsic interest rate risk from their core products than life insurers have from theirs. Bank loans typically have shorter maturities than life insurance liabilities, and they often have floating interest rates (which reduces the impact of interest rate changes). Bank deposits also tend to have short maturities.

TABLE 10

Relationship between interest rate sensitivity and firm characteristics

	1 Pre-crisis	2 Low-rate	3 Pre-crisis	4 Low-rate	5 Pre-crisis	6 Low-rate	7 Pre-crisis	8 Low-rate
Ln(total assets)	−0.034 (0.022)	−0.157*** (0.045)	−0.039* (0.022)	−0.160*** (0.049)	−0.049* (0.028)	−0.155** (0.061)	−0.034 (0.022)	−0.148*** (0.045)
Noninsurance assets	—	—	0.296 (0.235)	0.117 (0.579)	—	—	—	—
Separate accounts	—	—	—	—	0.094 (0.111)	−0.013 (0.257)	—	—
Interest-rate-sensitive liabilities	—	—	—	—	—	—	−0.187 (0.373)	−1.076 (0.737)
α (constant)	0.333 (0.227)	1.485*** (0.492)	0.310 (0.225)	1.489*** (0.503)	0.411 (0.246)	1.474** (0.551)	0.350 (0.233)	1.516*** (0.481)
Observations	26	25	26	25	26	25	26	25
R-squared	0.094	0.342	0.152	0.344	0.121	0.343	0.104	0.400

*Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
Notes: This table reports regression results where the dependent variable is γ from the firm-level regressions using equation 1 (p. 59) for life insurance firms in the sample (table 3, p. 60). The ln(total assets) variable is the natural log of average total assets for a firm. The noninsurance assets variable is the average share of assets in the firm that are not either life insurance assets or property and casualty insurance assets. The separate accounts variable is the percentage of total life insurance assets a firm reports as being in separate accounts. The interest-rate-sensitive liabilities variable is the ratio of interest-rate-sensitive liabilities to general-account liabilities. The pre-crisis period is August 2002 through July 2007. The low-rate period is August 2010 through December 2012. Each regression includes one observation for each firm in the sample. The standard errors are in parentheses.
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Property and casualty insurance provides protection against risks to property, such as fire, theft, or weather. The PC insurance industry is much smaller in size than the life insurance industry, and it held $1.63 trillion in assets in the fourth quarter of 2012.[59] The liabilities of PC insurers tend to be of significantly shorter length than those issued by life insurance firms. Whereas most life insurance policies remain in effect for several years, if not decades, most PC insurance policies must be renewed annually. For example, an automobile insurance policy covers a customer for events over a period of a year or less. On the whole, the annual renewal for these policies lessens the exposure of PC insurers to interest rate risk because these insurers can adjust policy prices to reflect current interest rates. Moreover, short policy lengths lead PC insurers to invest in short-maturity assets, which, relative to long-maturity assets, have values that are less affected by interest rate fluctuations.[60] In addition, PC insurers do not offer savings products.

The net interest rate risk exposure of insurance firms and banks depends not only on the interest rate sensitivity of their core products, but also on how these types of firms do asset–liability management. We have discussed how life insurance firms tend to match their long-term liabilities with long-term assets, such as corporate and government bonds. Banks also do asset–liability management, and PC insurers do so as well. Thus, we turn to an examination of stock returns to estimate net interest rate risk exposure among the different types of financial intermediaries.

We run our baseline analysis using the two-factor model (equation 1, p. 59) for banks and PC insurers to see how interest rate risk exposure differs across the industries. A firm is classified as a bank if it is or owns a U.S. commercial bank. We drop large banking organizations if they are foreign owned or if they primarily do nonbanking activities (for example, Charles Schwab). The 535 banks in our sample vary greatly in size: The large banking firms are significantly larger than the large insurance firms in our sample, while the small banks have assets on the order of those of the small life insurance firms in our sample.[61] In total, our sample contains less than 10 percent of the banks in the United States, but over two-thirds of all banking assets. The large banks are much more involved in nontraditional banking activities, such as derivatives, than small banks are. For this and other reasons, banking researchers often split banks by size when doing analyses. We do the same, splitting our sample into the banks that were part of the Federal Reserve's Supervisory Capital

Assessment Program (SCAP) test in 2009 (the SCAP banks) and those banks that were not (the non-SCAP banks).[62] Essentially, the SCAP banks are the large banks in our sample, while the non-SCAP banks are the small ones. The SCAP banks in our analysis have 64.3 percent of the assets in our banking sample as of year-end 2012.[63] As we did with life insurers, we rely on the SNL Financial classification to determine which firms are PC insurers. There are 94 PC insurance firms in our sample. PC insurance firms tend to be much smaller than life insurance firms: The median of the PC insurance firms' total assets was $3.6 billion,[64] while the median of the life insurance firms' total assets was $29.3 billion (table 4, p. 61).

Table 11 presents results from running the two-factor model for banks and PC insurance firms. For reference, we also include the results for life insurance firms from tables 6 and 8 (pp. 62 and 65, respectively). The interest rate risk exposure of banks is of a similar magnitude as that of life insurance firms, at least in the low-rate period (table 11, panel A). Prior to the financial crisis, the large (SCAP) bank stock returns were essentially uncorrelated with bond returns (as indicated by the small coefficient γ during the pre-crisis period in panels A and B of table 11), while the small (non-SCAP) bank stock returns were weakly positively correlated with bond returns (as indicated by the positive and statistically significant coefficient γ during the pre-crisis period in panel B of table 11). These results are broadly consistent with earlier studies.[65] The coefficient γ, our measure of interest rate sensitivity, fell sharply for both groups of banks from the pre-crisis period to the low-rate period. The SCAP banks had essentially no exposure in the pre-crisis period, but had an exposure similar to that of large life insurers in the low-rate period (see the low-rate columns of table 11, panels A and B). The non-SCAP banks had a slightly positive γ in the pre-crisis period and a small, negative γ in the low-rate period. So, banks were quite similar to life insurance firms in terms of interest rate risk exposure: Large firms had more interest rate sensitivity than small firms. This may be because large banks had a larger share of complex financial products and activities than did small banks.

It is apparent from the regression coefficients in table 11 that the median PC insurer had (at most) minimal exposure to interest rate risk in both the pre-crisis and low-rate periods. The median values of γ are –0.001 in the pre-crisis period and –0.025 in the low-rate period (table 11, panel A); both of these values are smaller in magnitude than the values of γ for large insurers—and they are smaller in magnitude even than the equivalent coefficients for small insurers. These results are not surprising given the structure of PC insurance liabilities.

Finally, table 11 also contains results for an analysis of managed care insurers. As with life insurers and PC insurers, we rely on the SNL Financial classification to identify managed care insurers. The results show that managed care insurers have returns that are positively correlated with bond returns in both the pre-crisis and low-rate periods (table 11, panels A and C). It is not surprising that managed care insurers differ from life insurers and PC insurers in this regard. Managed care insurance results are driven by how often policyholders claim benefits and how expensive the benefits are. Benefit costs are likely to be correlated with economic activity (for example, the less work there is, the fewer the work-related injuries) and the cost of health care and assisted living. Thus, interest rates may serve as a proxy for the omitted benefit cost variable for managed care insurers.

Overall, these comparisons suggest that the interest rate risk exposure of large life insurers was more significant than for small life insurers and other types of firms before the financial crisis, but their exposure is on the order of that of large banks in the low-rate period.

Robustness

Our results are robust to a variety of specification changes. We get qualitatively similar results when we replace the ten-year Treasury bond return with the five-year Treasury bond return, the ten-year Treasury bond yield, or a corporate bond return. We also get similar results if we use a Fama–French specification,[66] which includes controls for differences between small firm returns and large firm returns and for differences between firms with high book-to-market ratios and firms with low book-to-market ratios.

Conclusion

Interest rates in the United States fell sharply at the onset of the financial crisis in late 2007, and the United States is currently in an extended period of low interest rates. While low interest rates are seen to benefit the economy by facilitating investment and borrowing, a prolonged period of low interest rates poses challenges for certain sectors of the economy, such as life insurance. Life insurers, as part of their core lines of business, acquire interest-rate-sensitive liabilities and assets, many of which have embedded options whose value depends on interest rates. To gain a better understanding of the impact of prolonged low interest rates on life insurance companies, we study to what degree life insurers were exposed to interest rate risk in both the pre-crisis period and current low-rate period.

Specifically, we study publicly traded life insurance firms during the period August 2002 through December 2012. Before the financial crisis, large

TABLE 11

Regression results for financial intermediaries

A. Firm-level regressions for financial intermediaries: Median values for γ

	Pre-crisis	Crisis	Low-rate
Life insurers	−0.076	0.740	−0.196
Small firms	0.070	0.715	−0.049
Large firms	−0.105	0.965	−0.414
Banks	0.046	0.026	−0.080
SCAP banks	0.069	0.078	−0.395
Non-SCAP banks	0.046	0.027	−0.061
PC insurers	−0.001	0.264	−0.025
Managed care insurers	0.139	0.659	0.457

B. Portfolio regressions for banks

	All banks			SCAP banks			Non-SCAP banks		
	Pre-crisis	Crisis	Low-rate	Pre-crisis	Crisis	Low-rate	Pre-crisis	Crisis	Low-rate
γ	0.101	−0.140	−0.414**	0.081	−0.235	−0.505**	0.141*	0.015	−0.175
	(0.082)	(0.319)	(0.187)	(0.095)	(0.395)	(0.219)	(0.076)	(0.207)	(0.125)
β	0.998***	1.622***	1.254***	1.003***	1.809***	1.298***	0.976***	1.236***	1.121***
	(0.043)	(0.111)	(0.085)	(0.049)	(0.138)	(0.100)	(0.039)	(0.072)	(0.057)
α (constant)	0.015	0.319	−0.061	0.005	0.357	−0.073	0.007	0.088	−0.003
	(0.073)	(0.394)	(0.163)	(0.085)	(0.487)	(0.191)	(0.068)	(0.255)	(0.109)
Observations	252	150	123	252	150	123	252	150	123
R-squared	0.707	0.636	0.787	0.647	0.589	0.749	0.726	0.702	0.856

TABLE 11 (CONTINUED)

Regression results for financial intermediaries

C. Portfolio regressions for PC insurers and managed care insurers

	PC insurers			Managed care insurers		
	Pre-crisis	**Crisis**	**Low-rate**	**Pre-crisis**	**Crisis**	**Low-rate**
γ	−0.031	0.241*	−0.044	0.010	0.915***	0.186
	(0.068)	(0.122)	(0.109)	(0.175)	(0.332)	(0.250)
β	0.686***	0.935***	0.708***	0.669***	1.213***	1.079***
	(0.035)	(0.043)	(0.050)	(0.091)	(0.116)	(0.114)
α (constant)	0.095	0.154	0.100	0.321**	−0.049	0.223
	(0.061)	(0.151)	(0.095)	(0.156)	(0.409)	(0.218)
Observations	252	150	123	252	150	123
R-squared	0.637	0.783	0.746	0.197	0.432	0.532

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Notes: The regressions take the following form:

$$R_{j,t} = \alpha + \beta R_{m,t} + \gamma R_{10,t} + \varepsilon_t,$$

where $R_{j,t}$ = the return (including dividends) on the stock of firm j in week t, $R_{m,t}$ = the return on a value-weighted stock market portfolio in week t, $R_{10,t}$ = the return on a Treasury bond with a ten-year constant maturity in week t, and ε_t is a mean zero error term. For life insurance firms, the large firms are the ten largest firms by total assets at the end of 2012 in the sample (table 3, p. 60), and the small firms are the remaining 16 life insurers. Banks comprise all firms that are U.S. commercial banks or own such a bank except firms that are foreign owned or primarily do nonbanking activities. SCAP banks are the banks that were part of the Federal Reserve's Supervisory Capital Assessment Program (SCAP) test in 2009 (for details, see note 62, p. 74); the non-SCAP banks are the banks that were not part of this test. PC insurers are property and casualty insurers classified as such by SNL Financial. Managed care insurers are those classified as such by SNL Financial. The pre-crisis period is August 2002 through July 2007, the crisis period is August 2007 through July 2010, and the low-rate period is August 2010 through December 2012. In panel B, the portfolio regressions are for an aggregate portfolio of firms in each bank grouping. In panel C, the portfolio regressions are for an aggregate portfolio of firms of each insurer type (PC and managed care insurers). In panels B and C, the standard errors are in parentheses.

Sources: Authors' calculations based on data from Compustat; French (2013); Haver Analytics; SNL Financial; and CRSP®, Center for Research in Security Prices, Booth School of Business, The University of Chicago (used with permission; all rights reserved; www.crsp.uchicago.edu).

life insurers' stock returns were essentially uncorrelated with ten-year Treasury bond returns. After the crisis (that is, in the recent low-rate period), the stock returns of large life insurers were negatively correlated with the returns on ten-year Treasury bonds. We find that the average level of large life insurers' stock returns is lower now than in the pre-crisis period, and these returns are more sensitive to changes in interest rates. These findings are consistent with two observations. First, the rapid decline in interest rates during the financial crisis and Great Recession left many of the guarantees in insurance products in the money and were associated with policyholders being less likely to withdraw the cash value of their policies. This finding has led life insurers' share prices to react more to changes in interest rates. Note that the stock returns for small life insurers react less to changes in bond returns than those of large insurers. Second, some insurance products such as fixed-rate annuities are not very attractive to customers when interest rates are low.

We compare life insurance firms to banks and property and casualty insurance firms. During the pre-crisis period, stock returns for banks and PC insurers moved very little with interest rate changes. In the low-rate period, this was still true for PC insurers and small banks. However, during the low-rate period, the exposure to interest rate risk of large banks was roughly similar in magnitude to that of large life insurance firms.

Life insurance firms play a large role in the U.S. economy. This study confirms that changes in interest rates are important to these firms. It also shows that the recent period of low interest rates has made it more challenging for life insurers to manage their assets and liabilities.

NOTES

[1]Board of Governors of the Federal Reserve System, Federal Open Market Committee (2012). The federal funds rate is the interest rate depository institutions charge when they make loans to each other—usually overnight—using funds held at the Federal Reserve. Note that more-recent policy statements are consistent with this previous statement (made in October 2012), but indicate federal funds rate changes hinge on economic conditions. For example, the FOMC's January 2013 press release stated that "the Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent and currently anticipates that this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored" (Board of Governors of the Federal Reserve System, Federal Open Market Committee, 2013).

[2]The other component of the Federal Reserve's dual mandate is price stability. For details, see www.chicagofed.org/webpages/publications/speeches/our_dual_mandate.cfm.

[3]Authors' calculations based on data from the Board of Governors of the Federal Reserve System (2013). We provide information on the composition of life insurers' assets later in this article.

[4]Authors' calculations based on data from the Board of Governors of the Federal Reserve System (2013). Foreign bonds are restricted to those held by U.S. residents.

[5]Authors' calculations based on data from the Board of Governors of the Federal Reserve System (2013).

[6]Authors' calculations based on data from SNL Financial. The S&P 500 Life & Health Index is a market-capitalization-weighted index of life and health insurers in the S&P 500 Index.

[7]Buck and Gibson (2012).

[8]The return on a bond over a period is the sum of the percentage change in the bond price from the start of the period to the end of the period and any coupon (interest) payments during the period.

[9]We do not focus on what happened to life insurance firm stocks and long-term Treasury bond interest rates during the financial crisis because interest rate changes occurred at the same time as a variety of policy interventions.

[10]More accurately, reserves measure the expected liability from a life insurance contract or annuity. Thus, we use reserves as a proxy for the share of liabilities stemming from each product type. We discuss reserve setting in more detail in the appendix. Since a reserve reflects the expected liability from issuing a contract, it can differ significantly from the face value of a contract. For example, a life insurance policy on a young person may have a low expected liability per dollar of face value because of a low expected mortality; however, a life insurance policy on an 80-year-old person will have a high expected liability per dollar of face value because of a high expected mortality.

[11]Prior to 2001, deposit-type contracts are included in the annuities values. Starting in 2001, deposit-type products are excluded from the measure of reserves shown in figure 2 (p. 50). Deposit-type contracts are similar to bank certificates of deposit in that policyholders receive interest and principal in exchange for making deposits.

[12]For more details on the history of annuities, see Poterba (1997) and American Council of Life Insurers (2012).

[13]In a defined benefit pension plan, the retiree is typically provided a monthly annuity that is based on years of service, final average salary, and age at retirement. The employer and/or employee make annual contributions to an employer-owned retirement fund; the investment and mortality risks are borne by the employer. In a defined contribution plan, the employer and/or employee make annual contributions to an employee retirement account, but with no guaranteed level of benefits to the employee at retirement; the investment and mortality risks are borne by the employee.

[14]A variable annuity is a tax-deferred retirement vehicle that allows the policyholder to choose from a selection of investments, and then pays out in retirement a level of income determined by the performance of the investments the policyholder chooses. A variable annuity is typically sold with one or more guaranteed benefit riders, which effectively guarantee a minimum rate of growth in the value of the annuity. We explain this type of annuity and the guaranteed benefit riders in greater detail later.

[15]For any life insurance contract, the payment resulting from a policy claim is made to the policy's beneficiaries, who are designated in advance by the policyholder.

[16]These reserve values and other similar values presented throughout this section are from authors' calculations based on data used in table 1 (p. 51).

[17]It should be noted, however, that the policyholder does not receive the death benefit once a policy is surrendered.

[18]When the policyholder reaches 100 years of age, the life insurance company pays the death benefit, even though death has not occurred.

[19]A similar product called variable life insurance has many of the same contract features as universal life insurance, but rather than the cash account value growing at a certain rate, it is invested in a portfolio of assets as directed by the policyholder and fluctuates according to the market value of the underlying investment portfolio.

[20]Increases in a universal life policy's death benefit typically require the customer to provide evidence of insurability. Otherwise, customers in poor health would have an incentive to increase their policies' death benefits.

[21]Note that in order for the contract to legally remain an "insurance policy," resulting in favorable tax treatment, the value of the death benefit may never fall below the value of accumulated cash surrender value.

[22]Note that for some annuities, policyholders have the option of withdrawing the cash value of their policies before the periodic payments begin. Doing so cancels the insurer's obligation to make future periodic payments. The mechanics of this option are discussed in more detail later.

[23]A small percentage of annuities are in none of these categories; 2.0 percent of the life insurance industry's total reserves are for such annuities, according to authors' calculations based on data from SNL Financial and Sullivan (2012). See table 1 (p. 51). They are typically group-pension-type products.

[24]Some new SPIA products contain cash refund features and other liquidity options that enable policyholders to achieve certain savings objectives. According to Drinkwater and Montminy (2010), 24 percent of SPIAs sold during 2008–09 contained cash refund features and 67 percent contained liquidity options.

[25]Authors' calculations based on data from Drinkwater (2006).

[26]When a policy is signed, the rules for the crediting rate are set. The rate is generally tied to long-term interest rates and can sometimes fluctuate based on the insurer's investment performance, but there is typically a guaranteed minimum rate that must be credited.

[27]Authors' calculations based on data from SNL Financial and Sullivan (2012).

[28]Note that policyholders choose whether and when to annuitize variable annuities. These decisions mirror those for fixed deferred annuities. By choosing to annuitize, policyholders can fulfill a protection objective. In contrast, by declining the annuitization option, policyholders forgo the protection objective in favor of fulfilling a savings objective.

[29]The policyholder is typically given a menu of various products in which to invest.

[30]Authors' calculations based on data from Paracer (2013) and Montminy (2013).

[31]Authors' calculations based on data from Hansen and Mirabella (2011).

[32]Ibid.

[33]This conclusion is from authors' calculations based on data from SNL Financial and Drinkwater (2003–13). The correlation between the annual surrender rate and the five-year constant maturity Treasury bond interest rate is 0.52 from 2002 through 2012.

[34]Policy loans are loans originated to policyholders that are financed by cash that has accrued in their policies; these loans do not depreciate in value because failure to repay them results in the termination of the policies.

[35]National Association of Insurance Commissioners (2009).

[36]RBC requirements are set to cover expected losses between the 92nd and 96th percentiles based on distributions of historical loss experiences (Earley, 2012; and American Academy of Actuaries, Life Capital Adequacy Subcommittee, 2011).

[37]Lombardi (2006).

[38]Ibid.

[39]Note that determining RBC for the insurance industry is much more complex than what has been described here; the RBC determination is based on examinations of correlation across risks, scenario analyses across several possible interest rate paths, and many other risk factors. For a more detailed account of determining RBC, please see American Academy of Actuaries, Life Capital Adequacy Subcommittee (2011).

[40]Indeed, in the fourth quarter of 2012, 75 percent of variable annuities were purchased with a minimum guarantee rider, according to authors' calculations based on data from Paracer (2013).

[41]Authors' calculations based on data for the fourth quarter of 2012 from SNL Financial. Derivatives as reported on the insurance industry's aggregate balance sheet make up 0.8 percent of total assets and 0.4 percent of total liabilities. The data are reported such that those derivatives with a negative book value are classified as liabilities and those with a positive book value are classified as assets. For more information on how life insurers report their derivative holdings, see the NAIC's annual statement instructions, available for purchase at www.naic.org/store_pub_accounting_reporting.htm#ast_instructions.

[42]Life insurers report the type of risk being hedged by derivatives in their quarterly reports (excluding derivatives used for synthetic asset replication, which account for 2 percent of the life insurance industry's derivatives by notional value). As of the fourth quarter of 2012, 67.6 percent of the notional amount was for hedging interest rate risk, 19.0 percent for equity index risk, and 13.4 percent for other risks (including credit and currency risk). These numbers are from authors' calculations based on data from SNL Financial.

[43]Authors' calculations based on data from SNL Financial.

[44]Authors' calculations based on data from SNL Financial. To get the net floating position, subtract the swaps paying at the fixed rate from the swaps paying at the floating rate (in figure 4, p. 59).

[45]In this article, we refer to bond returns, bond interest rates, and bond yields. A Treasury bond is issued at a price that is known as par (typically this is 100) and promises to make periodic (semiannual) coupon (interest) payments at a given interest rate. If the bond interest rate is 6 percent, then the coupon payments will be 3 percent on the bond's face value every six months. For a $100,000 face value bond, this is a $3,000 coupon payment to the bondholder every six months. Once the bond is issued, it can be traded. The price of the bond can either rise or fall but the coupon payments remain fixed. If the price of the $100,000 bond with a 6 percent interest rate falls from 100 to 90, then the bond costs $90,000 but the coupon payments are still $3,000 every six months. This would mean that the *yield* on the bond would increase. The yield on a bond is equivalent to the interest rate on a newly issued bond with the same maturity as the existing bond (calculating the exact change in yield from a given price change is complicated). The reason market participants typically refer to yield rather than interest rate is that the interest rate on a given bond is fixed at the time of issue but the effective interest rate to the purchaser of a bond after issue—that is, the yield—depends on how the price has changed. Finally, the return on a bond combines any change in a bond's price with the coupon payments. For the example here, if the bond price fell from 100 to 90 over a six-month period, the return would be a loss of 7 percent (a 14 percent annual rate) because there would be a 10 percent loss from the price decrease offset by the 3 percent coupon payment.

[46]For example, Allstate Corp., which owns Allstate Life Insurance Co. but derives a much larger share of its revenues from property and casualty (PC) insurance companies, is classified as a PC insurer. Also, note that we exclude insurance firms that are primarily engaged in managed care insurance. Carson, Elyasiani, and Mansur (2008) present evidence that accident and health insurance firms, such as those that engage in managed care insurance, have different interest rate sensitivities than life insurance firms. We present results for managed care firms later in the article.

[47]We drop American International Group Inc. (AIG) from the sample because of the government intervention to rescue it beginning in September 2008.

[48]This and other annual return values appearing in parentheses in this paragraph are from authors' calculations based on data used in table 4 (p. 61).

[49]In our sample, the return on a ten-year Treasury bond exceeds its average yield. This is because ten-year Treasury bond yields were declining during the sample period, so the bonds had capital gains in addition to their interest payments.

[50]The Great Moderation is a period usually thought to have begun in 1984 and lasting until the financial crisis that began in late 2007. Over this period, many economic time series exhibited less volatility than in the years preceding it.

[51]For details on the interventions involving these and other life insurance firms, see http://timeline.stlouisfed.org/index.cfm?p=timeline. Details on TARP are available at www.treasury.gov/initiatives/financial-stability/about-tarp/Pages/default.aspx. As noted earlier, we exclude AIG from our sample because of the recapitalization (government intervention).

[52]The duration of a payment measures how long a dollar of present discount value (PDV) is outstanding. The duration of a series of payments is the weighted average of the duration of each of the payments, with the weights being the PDVs of the payments. So, the duration of a firm is the weighted sum of the durations of its assets, liabilities, and off-balance-sheet activities.

[53]This result is from authors' calculations based on a ten-year Treasury bond interest rate of 5.0 percent and data in table 8 (p. 65).

[54]This result is from authors' calculations based on a ten-year Treasury bond interest rate of 2.5 percent and data in table 8 (p. 65).

[55]These results are from authors' calculations based on data in notes 53 and 54.

[56]When we run our baseline analysis using the two-factor model (equation 1, p. 59) for an equally weighted portfolio of small life insurers, we get positive but statistically insignificant coefficients for γ in both the pre-crisis and low-rate periods (results not shown).

[57]Brewer et al. (2007) use the return on bonds with a longer maturity than the ones we use (approximately 20-year remaining maturity, compared with the ten-year bonds in this article) for their interest rate factor, so the magnitudes of their coefficients are not directly comparable to the magnitudes of the coefficients in this article.

[58]Authors' calculations based on data from the Board of Governors of the Federal Reserve System (2013).

[59]SNL Financial.

[60]The PC insurance industry's fixed-income portfolio has roughly half the average maturity of the life insurance industry's fixed-income portfolio, according to authors' calculations based on data from SNL Financial.

[61]Note that because our sample includes only firms with traded stock, we do not capture the smallest life insurance firms and banks. Thus, any statements on firm size are not comments on the life insurance industry or banking industry as a whole. (Moreover, only PC insurance and managed care firms with traded stock are in the sample.)

[62]The Supervisory Capital Assessment Program (SCAP) was an exercise designed to estimate losses, revenues, and reserve needs for eligible U.S. bank holding companies (BHCs) with assets worth over $100 billion following different economic shocks (for details, see www.federalreserve.gov/bankinforeg/scap.htm). The assessments—often referred to as stress tests—were conducted collaboratively by the Federal Reserve, Office of the Comptroller of the Currency, and Federal Deposit Insurance Corporation. MetLife, a major life insurance firm, is also a bank holding company and part of the SCAP test. We classify MetLife as a (large) life insurance firm, but not as a bank. We also excluded Morgan Stanley, Goldman Sachs, American Express, and Capital One from our analysis.

[63]Authors' calculations based on data from Compustat.

[64]Authors' calculations based on data from SNL Financial.

[65]Brewer, Mondschean, and Strahan (1993) and Flannery and James (1984) found a positive but small and sometimes insignificant relationship between bank stock returns and bond returns—which is consistent with our findings for the pre-crisis period.

[66]Fama and French (1993).

APPENDIX: THE STRUCTURE OF LIFE INSURANCE RESERVES

Life insurance companies offer policies that deliver future payments to customers. These payments may be contingent on the incidence of unfavorable events (in the case of life insurance), may follow a specific schedule (in the case of annuities and deposit-type contracts), or may be influenced by a policyholder's discretion (in the case of policies that include a savings component). In all these cases, payments to a policyholder are expected to be made some time after—and in some cases, a considerably long time after—a policy's inception.

Because premiums are received often well before payments are made, life insurance companies are expected to hold assets that support these payments at all times. Therefore, when a life insurance company issues a new policy, it immediately sets aside a reserve on the liabilities portion of its balance sheet and accumulates a corresponding portfolio of assets to support it.[1] Conceptually, the reserve reflects the portion of a life insurer's assets that are pledged to a given policy. Reserves typically make up the vast majority of an insurance company's liabilities; at year-end 2012, they accounted for 90 percent of the life insurance industry's total statutory liabilities.[2]

An example of a simplified life insurance policy may best illustrate how companies set reserves. Assume that a one-year life insurance policy pays $100,000 if the policyholder passes away in the next year. In exchange, the policyholder pays a one-time premium of $1,000. The life insurer estimates that the chance of the policyholder dying within the next year is 1 percent. This implies that the insurer's expected future payment ("benefit") on the policy is $1,000 ($100,000 benefit × 1 percent probability of death). Given these assumptions, the life insurance company would have to create a reserve of $1,000 on the liabilities portion of its balance sheet, indicating the value of the expected future benefit. If the policyholder dies in the next year, the company pays out $100,000. If the policyholder survives, the company pays nothing and retires the $1,000 reserve (adds it to capital). If the life insurance company then sells 100 identical policies with this structure, it would record a reserve of $100,000 at the beginning of the year and expect to pay $100,000 in future benefits (one death per 100 policies).

Although this simplified example provides a good introduction to reserve setting, it does not account for certain important details. For example, because life insurance companies hold assets—typically fixed-income securities—to back their policy reserves, they have the ability to generate significant levels of investment income. This investment income can be used to support reserve growth and must therefore be factored into the reserve-setting process. In addition, future premiums from the policyholder can also be used to support reserve growth. Because our simplified example depicted a one-year policy, no future premiums were to be collected. However, for policies spanning multiple years, future premium contributions must also be factored into the reserve calculation.

Given these considerations, life insurance companies calculate the value that should be assigned to a policy's reserve according to a strict formula. At any given time, the value of the reserve is calculated as the present value of expected future payments to the policyholder (future benefits) minus the present value of expected future payments to the insurer (future premiums), that is,

$$Reserve = PV\,(Future\ Benefits) - PV\,(Future\ Premiums).$$

Note that several key assumptions must be made when setting reserves in this manner. For example, in calculating the present value of future benefits, the life insurer must estimate when the policyholder may cash in on the policy. For a life insurance policy, this may involve estimating the policyholder's age of death using a mortality table, which will determine when the policyholder stops paying the premium and when the insurer pays the death benefit. Meanwhile, in calculating the present value of both future benefits and future premiums, the life insurer must predict its ability to generate investment income using assets that are purchased with the policyholder's premiums. This assumption is referred to as the discount rate (that is, the interest rate on booked reserves and future premiums). In general, state insurance regulators provide comprehensive guidelines that govern the structuring of reserves, with many of the key assumptions set by the regulators.

Another simplified example helps illustrate how these added considerations affect reserve growth. Assume a 40-year-old customer owns a life insurance policy that promises to pay him $100,000 upon death. In exchange, the customer promises to pay the life insurance company $250 in premiums each year. The company expects to invest his premiums in assets that increase the reserve by 5 percent each year. For the sake of simplicity, we make two additional assumptions. First, we assume that the customer will reach mortality at exactly 100 years of age. Therefore, the probability of him living more or less than 100 years is zero. Second, we assume that the company incurs no expenses in acquiring and servicing the policy. Therefore, these expenses will not factor into reserve calculations. Given these assumptions, we can calculate what the reserve should be for each year of the policy. For example, immediately upon issuing the policy, the company sets aside a reserve of the following value.

$$PV\,(\textit{Future Benefits}) = \$100{,}000 \times (1.05^{-60}) = \$5{,}354,$$

$$PV\,(\textit{Future Premiums}) = (\$250 / 0.05) \times (1 - 1.05^{-60}) = \$4{,}732,$$

$$\textit{Reserve} = \$5{,}354 - \$4{,}732 = \$622.$$

Here, $100,000 is the benefit that will be paid to the customer upon death; $250 is the amount of premiums to be paid by the customer in each year of the policy; 5 percent is the expected amount of reserve growth each year; and 60 is the number of years left on the policy.

Now let us update this calculation ten years later so that there are 50 years left on the policy.

$$PV\,(\textit{Future Benefits}) = \$100{,}000 \times (1.05^{-50}) = \$8{,}720,$$

$$PV\,(\textit{Future Premiums}) = (\$250 / 0.05) \times (1 - 1.05^{-50}) = \$4{,}564,$$

$$\textit{Reserve} = \$8{,}720 - \$4{,}564 = \$4{,}156.$$

Given the same assumptions, only one value has changed: 50 is the new number of years left on the policy. As can be seen, the value of the reserve has substantially increased for two reasons. First, as time passes, the $100,000 death benefit that must be paid to the policyholder increases in present value. Second, as more premiums are paid by the policyholder, the present value of future premiums to be paid decreases. Given that the policy's reserving assumptions never change, these trends will persist until the policy expires. In the 60th year of the policy, the customer reaches death as expected.

$$PV\,(\textit{Future Benefits}) = \$100{,}000 \times (1.05^{-0}) = \$100{,}000,$$

$$PV\,(\textit{Future Premiums}) = (\$250 / 0.05) \times (1 - 1.05^{-0}) = \$0,$$

$$\textit{Reserve} = \$100{,}000 - \$0 = \$100{,}000.$$

There are no more premiums to be paid and no more years left on the policy. As can be seen, the value of the reserve equals the value of the benefit paid to the customer. The benefit has been financed by two streams of money: $15,000 ($250 in annual premium × 60 policy years) originates from premiums that have been paid by the customer to the life insurer; meanwhile, the life insurer has raised another $85,000 by investing the customer's premiums at a 5 percent rate of return.

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[1]The assets are purchased using the premiums that are paid by the policyholder.

[2]Authors' calculations based on data from SNL Financial.

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